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VOLUME II

THE VEGETATION OF LONG ISLAND

PART I

THE VEGETATION OF MONTAUK

A STUDY OF GRASSLAND AND FOREST

BY

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PREFACE.

This is the first of a series of papers on "The Vegetation of Long Island," which it was intended should be issued under one cover. To issue them as separate parts, as they are completed, now seems the better plan as not much has ever been written on this phase of Long Island plant life, and practically nothing at all upon the environmental factors which determine it.

Studies of the well-nigh world wide contest between grassland and forest are so common that it should be said that the peculiar climatic and topographic conditions at Montauk alone make necessary the publication of another such paper. As will be seen, the response of the vegetation at Montauk is in many ways unique.

The attempt to put into plain English what appears to be the vegetative history of Montauk, without using the multitude of terms that etymologically adroit ecologists have given us, may seem to demand some apology from my colleagues. But a glance at recent ecological literature shows that many of these terms are not yet free from confusion or controversy, whereas English still possesses the incomparable advantage of being understood not only by most ecologists, but by others.

In gathering instrumental data, in the identification of critical species, and in other ways, I have had assistance from various people whose special services are acknowledged in the different sections of the book. I am particularly pleased to make grateful acknowledgment to my friend and colleague, Major Barrington Moore, who has shown constant interest and helpfulness during the work, and especially during several trips to Montauk. To my assistant Helen Smith Hill I am under great obligation for efficient help in carrying through most of the details of instrumental work, of experimental cultures for testing the moisture-holding capacity and wilting coefficient of many soil samples, and in many other ways. The photographs, except where noted otherwise, were taken by the writer.

NORMAN TAYLOR.

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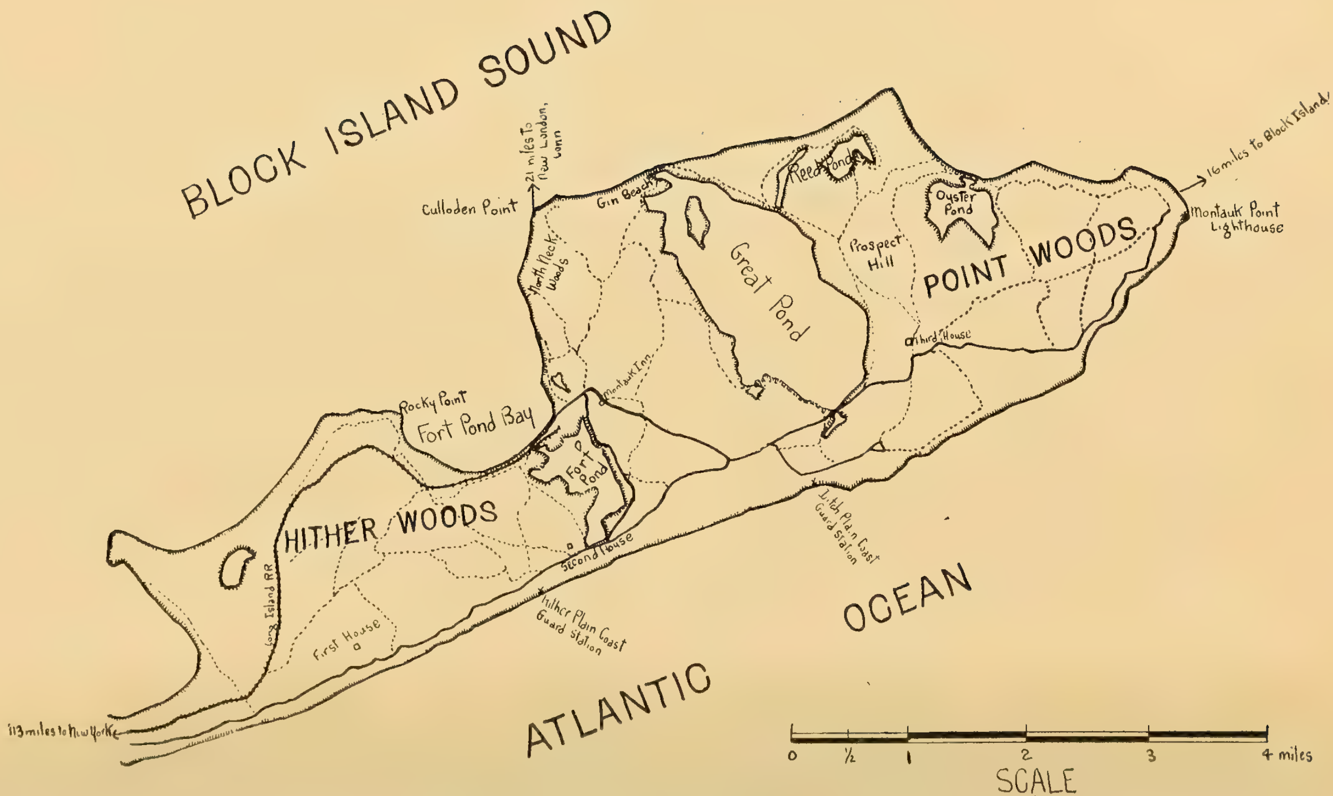


FIGURE 1. Map of Montauk, showing principal roads, trails, coast guard stations, lighthouse and other features. See Figure 2 for condensed panorama of the region from the Inn eastward.

MONTAUK AND ITS TOPOGRAPHY.

One hundred and thirteen miles from New York on the eastern extremity of the south fluke of Long Island is the peninsula of Montauk, famous since 1640 when Captain Lion Gardiner founded Easthampton, the present township of which includes Montauk.

In approaching it by train from New York, one passes, during the last few miles of the ride, through an apparently ancient oak forest, about four miles in extent, known from the earliest days as the Hither Woods. Quite suddenly the train debouches from these woods onto the open Downs, skirting the edge of a beautiful crescent bay, upon the beach of which the fishing hamlet of Montauk is picturesquely scattered. This tiny village, largely depopulated of its fishermen in the winter, is the last station on the railroad, and is seven miles by road from the lighthouse at Montauk Point, which is the easterly extremity of New York State.

The topography of Montauk is dominated by the kettleholes, and the areas between them, which in the case of treeless sections are known as The Downs, and give the whole Point a characteristic aspect. For miles one sees nothing but rolling hills, deceptive as to size and the depth of the kettleholes between them, mostly bare of trees, from the easterly edge of the Hither Woods, to just east of Great Pond.

J. A. Ayres who visited Montauk, and wrote an account of it in 1849, writes of the general aspect of the place as follows:

"Southeast, we have a very fair representation of the *hills of Montauk*. Of these hills it is almost impossible to convey a correct idea. Rounded and rolling, but in many cases quite steep and abrupt, not arranged in ridges, but scattered apparently at random; with no level land among them, but deep cup-shaped hollows seeming like reversed copies of the hills themselves; bare of trees and covered only with a smooth turf, as close as though it had been shorn, their appearance is *sui generis*. We cannot place ourselves on any part of the extent which bears the name Montauk, without fully understanding the propriety of the name. It is in truth a "Hilly Land." From Nommonock to Wamponomon* the rolling surface is unbroken, except by the ponds and one or two small spaces which are by courtesy called plains. The highest of these hills, in the western part of the peninsula, are those on which we are standing."

* Old names for the hills just east of Napeague, and for the "Turtle Hills" on which the Lighthouse now stands at the extreme Point.

The bottoms of four of these kettleholes are permanently occupied by water, viz.: Fort Pond, near the town; Great Pond,* the largest lake on Long Island, with a very considerable island near one end of it; Reed Pond which is little more than an offshoot of Great Pond; and Oyster Pond, the most easterly of all. Both the latter are small bodies of water, Great Pond is about two miles long and one wide, comprises 1300 acres, and occupies most of the center of the Point, while Fort Pond is of irregular shape and is about a mile in its longest dimension.

The kettleholes occupied by these ponds are the largest on the Point, most of the others not exceeding 6 to 8 acres, and scores of them only a few square rods in extent. Those kettleholes without ponds in them show all gradations between practical dryness and a water table that is only just above or beneath the surface. The nearness of this water table to the bottom of the kettlehole is reflected in the type of vegetation now found in them, or that is developing in some of those whose progression from early stages to final vegetative covering is still under way.

* Called in most old records and on some modern maps Lake Wyandannee. So in Dr. Dickinson's panorama, figure 2.

HISTORY OF THE POINT AND EARLY CONDITION OF ITS VEGETATION.

Casual visitors to Montauk are charmed by the wildness of the place, the desolate moor-like Downs, the depths of the kettleholes, some destitute of woody vegetation, others dark and even mysterious in their wooded interior. The feeling that the vegetation has always been so, and that from the earliest times the Indians, whose relics are common enough on the Point, must have roamed through a region such as our modern pedestrian sees, is natural enough.

While this may not be wholly true, it appears from a study of the records* of the earliest settlers that there has always been, within historic times at least, a distinct separation of grassland and woodland. While not necessarily of the same extent today as when the Indians of Montauk agreed with the settlers of Easthampton, on May 22, 1658, as to the use of the Point, there can be little doubt that some forest land, certainly the Hither Woods, and great areas of grassland, such as characterize it today, covered large areas.

In this first written agreement between Wyandanch, the chief of the Montauk Indians, and the settlers of Easthampton, it is stated that the latter had granted to them the privilege of "pasturing their cattle on Montaukett (the old name) for seven years." At the end of that period, and after his death, his daughter, Sunk-squa, made the following agreement with Easthampton on October 4, 1665.

"1. The bounds of the town east to the Fort-pond, and all the rest to the end of the island, to belong to the Indians; but not to be disposed of to any other than the people of the town.

"2. The inhabitants forever to have full and free liberty at any time to cut *grass on said lands*, and for feeding of cattle, but not till the corn, planted by the Indians, shall be taken off.

"3. If cattle trespass on the Indians, by reason of not keeping up the fence, the town to make satisfaction; and if Indian dogs do damage to cattle, they to make satisfaction.

* I am glad to make acknowledgment here for the use of the admirable collections of the Long Island Historical Society, which have been diligently searched for authentic records of the early condition of the vegetation, not only of Montauk, but of other parts of Long Island. To Miss Emma Toedteberg, the librarian, I am particularly grateful for making many helpful suggestions in the course of this part of the work.

"4. Indians not to set *fire to the grass* before the month of March, without consent of the town. In consideration of all which, the town engages to pay, yearly 40 shillings to said Sunk-squa and Indians, their heirs and assigns.

"Made and agreed to before me, Richard Nicoll.

"Matthias Nicoll, *Sect'y*."

The italics are mine.

As the town of Easthampton, which included all of Montauk, was settled in 1640, it is thus only twenty-five years later that the management of the peninsula becomes a matter of record, between the settlers and the Indians, who were friendly.

These records show that there was evidently a very considerable part of the peninsula in grassland at that time, but as to woodland, it is not so clear. There are, however, frequent references in these old records to the Hither Woods, which still exists at about the place designated in these early chronicles.

By the end of the century conditions at Montauk needed to be redefined and a new agreement was entered into between the Indians and the town of Easthampton. It gives us such a good picture of conditions in 1702, or sixty years after the first whites came to that end of Long Island that it is inserted here complete.

"The said Indians are to fence in as a general field what land they see cause upon the Northneck [near Culloden Point] which lies between the Fortpond to the westward and the Greatpond to the eastward, for their planting field; and wholly to leave the land to the eastward of the Greatpond unto the English; and the said Indians shall from year to year lay and keep open their field or fields for the said town's cattle to feed upon (excepting only some small fields which they may keep inclosed for winter wheat or grass not exceeding thirty acres;) and the time of the said field or fields shall be laid open is to be upon the tenth or fifteenth of October, and so to continue open until the twenty fifth day of April after. The said Indians making and continually keeping and maintaining a good sufficient fence about all their fields at their own expense, cost and charges.

"That if the said Indians or their posterity as long as they live upon Meantauk [another old spelling] shall cause to leave that field and remove to the eastward of the said Greatpond, then they shall wholly quit the Northneck, and shall have liberty to fence in a field from the southwardmost part of the Greatpond running southward to a small round swamp near the dich bars; [the present Ditch Plain] and so from thence to run in at the southeast part of the oyster pond; and to plant and improve the land on the northward part of the said line of fence; and they and their posterity after them shall have liberty, as often as they see cause, to exchange their field from one side of the said Greatpond to the other; still sufficiently

fencing their fields at their own costs and charges, and observing the rules of laying them open as is before prescribed.

"And the said Indians and their posterity shall have liberty to keep upon the said land two hundred and fifty swine, great and small; the said Indians paying all such damage to the English as they shall sustain by the rooting of the said swine; and to keep horse kind and neat cattle not exceeding the number of fifty in all, and to get hay to winter them; but they are not to take any horse kind, cattle or swine to keep for any other person, nor to sell, give or any way dispose of any grass or hay to any person whatsoever; nor shall they have liberty to permit or let out any land to any person, either to plant, sow, or any other way to improve.

"That the said Indians and their posterity after them shall have liberty to make use of so much of that timber of the town on this [west] side of the Fortpond [the Hither Woods] as they shall need to fence in their general field, after they have used all the fencing stuff that is upon the Northneck, if the English do not lay out that land into parcels or lotments and improve the same. In testimony hereof, we the parties to these presents have hereunto set to our hands and fixed our seals enterchangeably, this 3rd day of March 1702/3."

From this it appears that there was certainly both timber and grassland at Montauk, both east and west of Great Pond, but ten years later there can be no doubt about the shortage of timber, for records of the town of Easthampton, dated April 7, 1713, have this to say about the question;

"Also in regard of the scarcity for timber at Montauk for the enclosures and for the prevention of its being destroyed or improved to wrong uses, it is ordered by the said Trustees that whosoever shall presume to fell or cut down tree or trees standing on any part of Mentauk [another old spelling] or carry or any way bring off from Mentauk any part of its growth by land or water except such as have authority so to do by virtue of some former deed or contract or by permission from the Trustees for the time being, he or they for so offending shall forfeit to the use of said Trustees for each and every tree felled or cut down aforesaid the sum of ten shillings and for each and every load of timber any way carried off as aforesaid the sum of forty shillings."

At the end of the year, in casting up the accounts of expenses of Montauk, which was a common pasturage, appear two significant items, thus:

	s.	d.
To Jeremiah Miller for carting 1,000 feet of boards to Montauk............	5	6
To Stephen Leek for carting 2,000 feet of boards to Montauk............	13	0

In fact in 1676 there were already signs that our ruthless ancestors began to see where their methods would lead them, for David Gardiner in his "Chronicles of the Town of Easthampton" says:

"The rapid diminution of timber had attracted attention as early as 1676, when at a Court of Sessions held at Southold, by his Majesty's

authority, it was ordered 'that no person not having an allotment and thereby a right in the commons should cut timber in Easthampton.' It now became necessary to provide against the frequent fires, which were found more destructive than the trespasses of individuals, and in 1710, the Trustees were authorized to call out the inhabitants to assist in extinguishing them. Upon the erection of the church a few years afterwards, it was found necessary to resort to Gardiner's Island for timber of sufficient size for the frame."

Besides this unmistakable evidence of the presence of forest, the protection of which had already become a matter of concern, the village records give us many hints of the importance of the grassland at Montauk. On June 20, 1744, they authorized "Captain Baker to build a house for the shepherds west of Fort Pond." And forty-three years later there appeared in the town records the following, under date of January 22, 1787. (Records of the Town of Easthampton **6**: 252. 1889.).

"1st. That all the hither end of Montauk west of the fort pond, shall be improved, to keep sheep for the benefit of the proprietors, and that all the cattle and horses shall be kept to the eastward of the said fort pond.

2d. That sixty-four sheep shall be allowed to go on one whole share, and in the same proportion for a greater or less right, and that four sheep shall go on and be entered in lieu of one neat beast, and that the lambs shall be entered on right, the same as grown sheep, by the first Wednesday in November, or be liable to poundage as grown sheep, and that all sheep that shall be found grazing on said land of Montauk not having right or not being duly entered, shall be impounded, the owner or owners of all such sheep so impounded paying two shillings for each sheep so impounded."

During the Revolution we get a vivid picture of the amount of grazing for on July 5, 1775, "The people of East and Southampton pray Congress that Captain Hurlbert's company, now raising for Schuyler's army, may remain to guard the stock on the common lands of Montauk (2,000 cattle and 3 or 4,000 sheep) from the ravages of the enemy." This was granted by Congress on July 31, 1775, but in spite of it the British took the cattle from Montauk on August 23, 1779.

That there may have been forests at Montauk greater than those found at the present time is indicated by Thompson in 1839, in the first volume of his "History of Long Island' (page 307) where he says: "[The] Peninsula of Montauk, containing as it does more than 9,000 acres, constitutes a considerable portion of the town (Easthampton). The timber once so abundant has now greatly depreciated." Such records of Thompson, and they have many times been repeated by Prime, Furman, Ross, Gabriel and other historians of Long Island, may be more true than they realized. While within *historic* times there is scarcely any evidence of great changes, as to

the distribution of grassland and forest at Montauk, there may well have been much greater areas of forest in pre-historic days. Further details of this will be found in the summary.

Not only the disturbance of the vegetation in the seventeenth and eighteenth centuries, and the grazing which has continued ever since (now much reduced in volume from what it was during the Revolution) but still another upheaval of the vegetation occurred during the Spanish-American war in 1898. At that time thousand of troops were quartered there and practically all the land between Fort and Great Pond was covered with troops and their equipment. It was also used as an aviation station during the Great War, but, so far as disturbance of the vegetation is concerned, on a much reduced scale. During 1921 and 1922, however, part of the area east of Fort Pond was used as a training ground for artillery regiments, whose manoeuvering and shooting destroyed large tracts of the Downs vegetation.

Montauk is a region, then, that has been through many phases in the disturbance of its vegetation, and in interruptions to the natural fulfillment of its vegetative destiny. This is now going on, in some places rapidly, and in others hardly at all, as the sequel will attempt to show. One interesting fact about the vegetation of the whole Point, in spite of all these disturbances, is the comparative scarcity of weeds of introduction, which are noticeably fewer than in other parts of the Island. This is due to their failure, with one or two exceptions, to compete with the wild vegetation, which over great areas of the Point, consists of singularly close-knit, so-called 'closed' associations, and to the minute fraction of the Point now under cultivation, scarcely ten acres.

From what has preceded it would appear that the present vegetation of Montauk is to be viewed as exhibiting various stages in the development or perhaps replacement of forest covering as that is possible on the open downs, and in the face of environmental conditions to be considered later. The wind, the lack of moisture on the upper part of the downs, its presence close to the surface in many kettleholes,—all these play a part in determining the rapidity and the type of this process.

Several well marked types of vegetation are to be seen there now, and a description of these, with some notes on their probable position in the scheme will be given in the following account of "The Downs," "The Kettleholes," "The Hither Woods," and the "Region East of Great Pond."

These four have been selected because in them are to be found ecological problems, that are probably of more interest than anything else on Long Island. In them are well illustrated the all but world wide conflict of

grassland and forest. What the determining factors are behind that conflict will be dealt with, having in mind that much experimental work still remains to be done in unfolding the true story of the conflict. We may see and describe the results of it, hint, perhaps at the probable major factors of the struggle, but only by experimental work on the direct action of the wind, and some other environmental influences can we hope to come at a true explanation.

These do not necessarily comprise all the vegetation types to be found at Montauk, there are the ponds, for instance, or the salt marshes, and sand dunes. The latter, however, are not greatly different from similar places all over Long Island, and for that reason descriptions of them will not be repeated here.

THE VEGETATION TODAY.

The Downs.

Some Englishman familiar with the Downs of Sussex and neighboring counties must have first applied the term to the rolling, apparently grass-covered, hills of Montauk. Except for the lack of chalk, the similarity to the South Downs is remarkable. Of course the plants in the English locality are different, but topographically, and so far as the general appearance of the vegetation is concerned the areas are quite similar, except that the Montauk Downs are all smaller and lower. The Downs in England are probably very primitive and, as suggested by A. G. Tansley, in "Types of British Vegetation," (pages 173 and 174) were never forested. He writes of the grassland association that, "It is unlikely that primitive man was responsible for the disforestation of such great areas of the chalk upland as are marked by traces of his existence, and the conclusion is therefore indicated that much of this grassland is primitive, or at least has existed since the conditions of climate resembled at all closely those at present obtaining."

It is scarcely credible that the Montauk Indians, with the crude implements which they were known to have had before the advent of the whites, could possibly have cleared such extensive areas as the English found covered by open Downs (approximately 6,000 acres), if most of it was primitively covered with woods.

And even if there had been some ancient cutting by the Indians, it may well be that at Montauk, as on the coast of Denmark, afforestation is impossible on certain specially exposed parts of the peninsula.

At the present time the dominant plant of the Downs is the grass *Schizachyrium scoparium*, which is of wide distribution over the greater part of the United States, and on Long Island is dominant mostly on these Downs, and on the Hempstead Plains. It is this plant that makes the generally grass-like covering of the Downs, and tinges with purplish-russet colors a landscape that is wonderful in September and October.

While *Schizachyrium scoparium* is dominant, there is associated with it a group of herbs that during different seasons, and because of their color, give definite character to the Downs: *Antennaria plantaginifolia* early in the season makes great areas of white cottony flower masses; in August and late July, myriads of *Polygala polygama*, with racemes of rose-purple

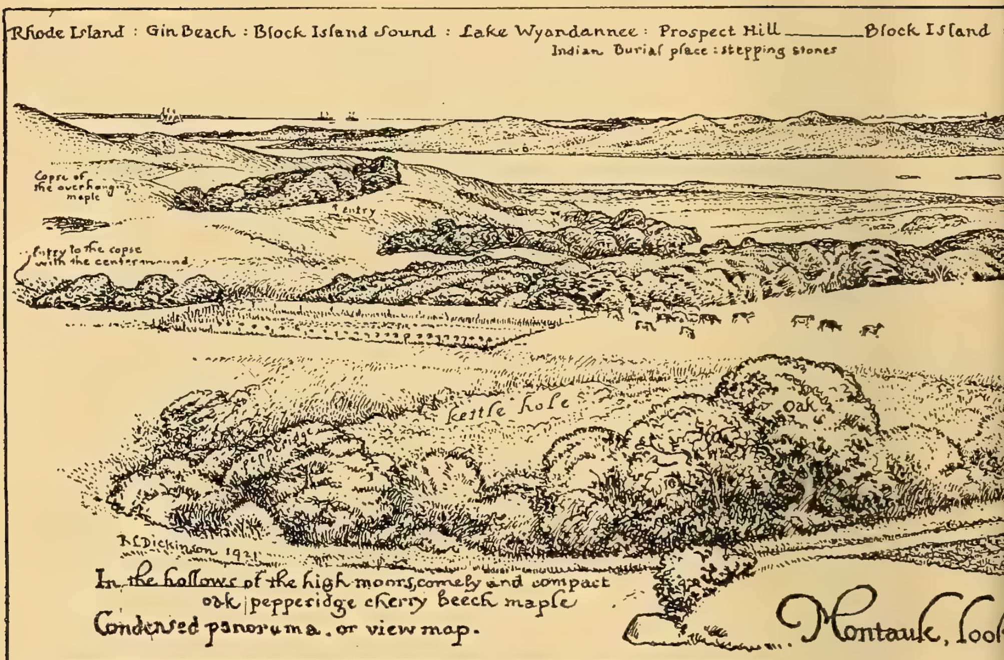
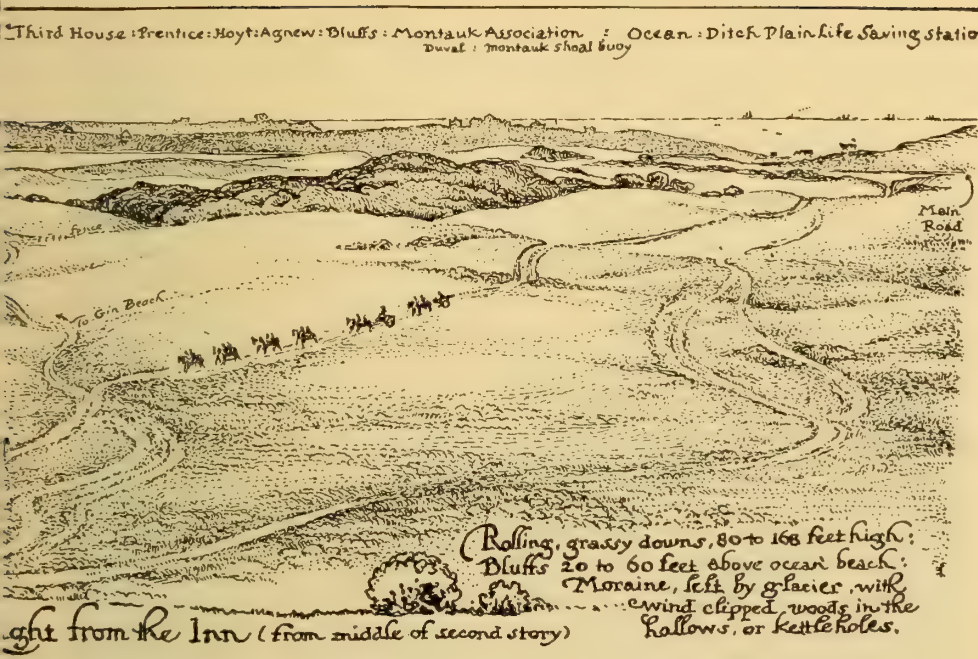


FIGURE 2. Panorama of Montauk. From

(sometimes white) flowers give midsummer color to the hills, which are often splashed at the same time with scattered patches of the white-flowered *Sericocarpus asteroides*. A little later untold millions of *Agalinis acuta*, with small purple flowers, give a new note of color, followed by the violet-colored or often paler, *Ionactis linariifolius*, with its aster-like ray flowers. Pages of description could be written of this ever changing panorama of flowers over the Downs, to the possible exclusion of a detailed account of the composition of this vegetation.

Considering first the herbs, which make up nearly all the vegetative covering of the Downs, it appears possible to separate them into groups as to their frequency of occurrence. In the following list the dominant species comes first, followed in order of frequency, by those which, while still very common, are subsidiary:

Schizachyrium scoparium
Juncus Greenei
Deschampsia flexuosa
Sorghastrum nutans



ıdly contributed by Dr. R. L. Dickinson.

Polygala polygama
Sericocarpus asteroides
Antennaria plantaginifolia
Agalinis acuta

It is surely not without significance that these herbs are all perennials, able to endure the winter with some degree of certainty, and that all show some measure of protection against the wind. In the case of the grasses, and of *Juncus Greenei*, *Polygala polygama*, and *Agalinis acuta*, the leaves are so narrow as to offer little resistance to the wind; and partly in *Sericocarpus*, and wholly in *Antennaria plantaginifolia* the leaves are practically flat on the ground and offer no resistance at all.

These eight plants make up the great mass of the herbaceous vegetation of the Downs. By weight and mere bulk they far exceed all the rest of the herbs put together, for as will be shown presently, many other species found there are rare and some have only been seen a time or two. The fitness of these eight species for their particular role in the covering of the Downs is worth some consideration. Their adaptability to winds has already been

noted but some account of their distribution and habits of growth may throw light on their peculiarly effective place in the vegetation of these rolling hills.

The grasses *Schizachyrium*, *Deschampsia*, and *Sorghastrum*, mentioned above, and *Juncus Greenei*, are all plants that grow in close, dense tufts,

FIGURE 3. General view of the Downs at Montauk. The dark spots are mostly bayberry thickets (*Myrica carolinensis*). The dominant grass is *Schizachyrium scoparium.*

or clumps, and do not tend to make a true turf, of which, because of this habit, and the admixture of other species, there is practically none at Montauk. In a region so grass-like in character, the predominance of species that do not make real turf is somewhat curious. Perhaps of significance is the presence of the lichen, *Cladonia rangiferina*, which often carpets the Downs and through which all the species are apt to force

their way. All these grasses and *Juncus Greenei*, one of our only dry-land rushes, are plants of wide distribution outside of Long Island.

In the case of *Polygala polygama*, while it is of wide general distribution, locally it seems to be confined to the coastal region of Long Island and Staten Island. It is nowhere more common than at Montauk, where the usually uncommon white-flowered form is certainly not rare. Its great profusion among the grassland vegetation is perhaps due to its stiff wiry stem and foliage, so that it appears to be peculiarly unpalatable to cattle.

Sericocarpus asteroides, the tallest of all these primary species on the Downs, has also the broadest and most succulent leaves of all of them. So many are basal, however, and lie practically flat on the ground that they neither offer resistance to the wind, nor can they be nibbled by cattle. Perhaps the salvation of this white-flowered composite is its tough stem, only sparingly furnished with leaves, and its habit of nearly always growing isolated, not making such attractive grazing as the grasses, which, while they make no turf, are often found in dense clumps a foot or more in diameter. This plant is otherwise known through the eastern part of the United States.

Much the same is true of the survival of *Antennaria plantaginifolia*, with the additional fact of the soft white, almost velvety, covering of the leaves. This not only retards transpiration in a region where this is very rapid, but also protects the plant from cattle, who never seem to touch it. The plant is common throughout eastern North America.

While these eight species make up the mass of the herbaceous vegetation on the Downs, they are, of course, associated with many other plants, some of them common enough, others only scattered. These secondary species of herbs, arranged in the order of their frequency, are as indicated below:

Ionactis linariifolius

Agrostis alba

Whether native in the north, or naturalized from Europe, this grass is at Montauk a relic of the great herds of cattle in the past. A good illustration of an introduced plant thoroughly mixed with the native vegetation.

Chrysopsis falcata

Crocanthemum canadense

Crocanthemum majus

Euthamia tenuifolia

Lechea villosa

Solidago nemoralis

Much reduced in size over plants from the central part of the Island.

Aster patens

Also *A. phlogifolius*, if that species, so far as Montauk specimens are concerned, be more than a mere form of *A. patens*.

Baptisia tinctoria

The tallest herb on the Downs, and very noticeable, as it is dotted all over the Point and every individual is made conspicuous by its stiff dome-like habit, instead of being merged in the general mass of the vegetation.

Carex Muhlenbergii

Chrysopsis mariana

Aster ericoides

Hieracium scabrum

Aster multiflorus

Often making exclusive patches, and rarely over six inches high, usually less. Its stunted wind-wrenched habit of growth is one of the most characteristic transformations of species at Montauk that are elsewhere taller and normally developed. Its dense masses of tiny white flowers, often flat on the ground, emphasize strikingly at flowering time, the reaction to the wind of this Aster.

Polygala viridescens

Potentilla canadensis

Also the form known as *P. pumila.*

Solidago rugosa

Much reduced in size over plants near the bottom of kettleholes, where the species is more abundant than on the Downs.

Viola fimbriatula

Kneiffia Allenii

A plant long thought to be endemic at Montauk, but now found elsewhere on Long Island. Its golden yellow flowers, low habit, and very general distribution over the Downs add a note of color in midsummer.

Galium pilosum

Cyperus filiculmis

Panicum columbianum

Achillea Millefolium

Another relic of man. A beautiful pink-flowered form is sometimes met with, particularly on the Downs just east of Great Pond.

Anaphalis margaritacea
Sarothra gentianoides
Panicum Scribnerianum
Hieracium marianum

While the foregoing lists of the primary and secondary herbs include, broadly speaking, the herbaceous vegetation of the Downs, other species are, of course, found there. These occasional specimens, erratic in their distribution, sometimes seen only once, add interest to the flora, without being of much importance in the development of it. A list of these species follows. All have been seen at least once, some are locally quite common. These are not arranged according to frequency of occurrence:

Sisyrinchium atlanticum and S. arenicola
Blephariglottis lacera
Ibidium gracile
Polygonella articulata
Potentilla monspeliensis
Lespedeza capitata
Cathartolinum striatum
Cathartolinum medium
Hudsonia tomentosa
Oenothera Oakesiana
Oenothera muricata
Bartonia virginica
Koellia incana
Koellia mutica
Trichostema dichotomum
Linaria canadensis
Plantago aristata; rather rare as an introduced plant.
Hieracium Gronovii
Eupatorium hyssopifolium
Eupatorium Torreyanum; also found near Culloden Point, but rare.
Solidago bicolor
Solidago juncea
Cirsium horridulum*

* This plant furnishes a good example of the possible changes in herbaceous vegetation of the Downs. Dr. Arthur Hollick who visited the region in 1890 wrote (Bull. Torrey Club **18**: 256. 1891) that "Some four years since [1886], so my driver informed me, a few plants of *Cnicus horridulus* made their appearance near the western edge of the hills. The prevailing winds scattered the seeds toward the east, until now [1890] it has complete possession over miles of what was formerly fine pasture land." Today nothing like such frequency is to be found.

Aster dumosus
Leptilon canadense
Erigeron pulchellus
Erechtites hieracifolia.

These, with the primary and secondary species, make an essentially complete list of the commoner herbs of the Downs. Other species could be included,* and more undoubtedly will be found, but for our general purpose of presenting as complete a picture of Montauk vegetation as possible, these will serve. So far as the Downs are concerned, *Baptisia tinctoria* is the tallest of these herbs and becomes therefore much more conspicuous than its actual frequency would suggest.† Practically all the other species, at least so far as their wind-swept habitat at Montauk has developed them, are low and hug the ground. Indeed so closely is this done, so perfectly does the open Downs' vegetation cover the hills, that, with the exception of these sentinel-like domes of *Baptisia tinctoria*, the hills of grassland look from a distance as though they were mown. Every undulation of the ground is shown and almost nowhere, as in so many of our landscapes, is the topography obscured by the vegetation.

The beauty of the Downs vegetation, so relatively limited as to species, and yet so perfectly fitted to its environment, should not blind us to the fact that the region is within the general forest area of northeastern America, that forest cover is found in considerable quantity in the Hither Woods, the North Neck Woods, Point Woods, and in many of the kettle-holes. Whether or not these bare downs were once covered with forest, large areas of them today appear in a state of stable equilibrium. Woody vegetation on these wind-swept hills appears next to impossible, and yet there are evidences that some form of woody vegetation is making an attempt to cover at least part of what is now grassland.

There are to-day hundreds of tiny patches of "bush" scattered over the Downs, some only a foot or two in diameter, others covering, especially in

* One curious failure of a rather typically grassland plant to become established at Montauk is the case of the bird's foot violet (*Viola pedata*). This plant, which occurs in tremendous profusion on the Hempstead Plains, has never been recorded from Montauk.

† Mrs. Theodore Conklin, who has lived on the Point for many years told the writer (1920) that it is only since the Spanish American War in 1898, that *Baptisia tinctoria* has been found on the Downs. She relates that a few years after the soldiers left, the autumn and winter winds swept great quantities of the 'tumblers' against the side of "Third House," her home for many years. This was unknown before 1898. The case of *Cirsium horridulum* has already been mentioned, so that we have, within thirty years, two conspicuous plants that have [perhaps only temporarily] usurped these Downs, without changing the dominantly grassland character of the vegetation.

the lee, square rods in extent. To what chance of nature, or freak of the wind, to possible fires, or to the idle grazing of cattle, the origin of these tiny patches of bushes is to be attributed, no one can say. It is certainly true that they are more frequent and larger toward the bottoms of the kettleholes into which the Downs vegetation frequently penetrates, and in the lee. Their striking dark green foliage, against the purple and tan of the grassland, is obvious for a mile or two.

Before considering what role these patches of "bush" can play in the vegetation scheme of Montauk, let us record the species that make up these little islands of thicket in an ocean of grassland. Almost without exception, the major portion of these islands is made up of the Bayberry (*Myrica carolinensis*), very often associated with which will be *Rosa carolina*, and perhaps the whole mass bound together with *Rubus procumbens* (which often scrambles out into the grassland), or *Smilax glauca*. It is not without interest that both these binders make prickly forage, and that in nearly every one of hundreds of such patches of "bush" that were examined, one or both of these vines was to be found. Both the Rose and the Bayberry, under normal circumstances, would be several feet tall, here they are rarely more than a foot. There are scores of places where the wind keeps these flattened down so that while the patch of bushes may be many feet across, the shrubs will be only six inches high. Sometimes, but not very often, a slight undulation, a fortuitous boulder, with which the Point is strewn, or an effective lee will invite greater growth of these bushes. Such accidents seem always to be utilized to the full, and where they are operative enough, a species of Shad Bush (*Amelanchier intermedia*) will often get a foothold.

From this stage in the development of a patch, which may start with a single sprig of Bayberry, and end with a forlorn and stunted tree in the center of it, no one knows how long a time may have elapsed. Certainly in some of these patches such gnarled and stunted trees are to be found. They are never much over four feet tall, towards the tops of the Downs, and in many of the patches destroyed utterly by the wreaking of the wind. But the fact remains, that occasional trees do start in such patches, and that they certainly start nowhere else on the open Downs. The process is infinitely slow, the number of failures is large, and the number of patches of bush that seem the same, year after year, is rather striking evidence that even with the slight protection of Bayberry thickets, trees can hardly start and maintain themselves on the open Downs. Nevertheless, such protected spots, bleak though they appear to be, do sometimes nurture a young oak, or black cherry, or very rarely, a gray birch (*Betula populifolia*), and thus justify their existence as a stepping stone to something bigger, if not more picturesque.

Upon this conception, the Downs show infinite gradations between, as after temporary slides of sand and gravel, perfect nakedness and the attempt to produce some sort of woody vegetation. Because such a large part of Montauk Point is occupied by these open Downs, where available water is scarce, and the exposure to the winds is terrific, all expectation of a rapid development of forest is certainly hopeless. Where that one element, water, is added, as in the kettleholes, and there is protection from the wind, the change is abrupt and convincing. With almost perfect drainage, a little less than the average Long Island rainfall, but with twice the wind, with no shade, and even now a few cattle at large, the wonder is not that the Downs has developed a struggling tree here and there, but that it has not stayed permanently and exclusively grassland. At least some evidence from the plants points the other way, and as we shall see, there are other phases of the Montauk vegetation, beside the Downs, which seem to argue that vegetation, like the grassland, or the patches of "bush," or the kettleholes, is a complex organism that is born, develops, and ultimately reaches a climax of its career before death, or transition to something else. In such a scheme the Downs vegetation is in one of the earliest, and it may well be arrested, stages of development, where the grassland predominates, slightly more developed where patches of "bush" have started, still farther along where such patches have nurtured a small tree, which in the end, may form a nucleus for a new type of growth, made up of shrubs and trees, which is near the climax condition. It should not be overlooked that while the climax seems to be the forest, it is the youngest, because the most recently developed, of all the types of vegetation now found on the Downs, as the grassland is the oldest. Large areas of grassland have no *Myrica* in them, and in spite of a rainfall that should permit forest covering, may be edaphically incapable of producing it. Such areas, with apparently permanent grassland on them, are certainly examples of an arrested climax. Rainfall would normally permit forest cover, but wind velocity and insufficient retention of water on the slopes are inhibiting factors that are strong enough to stop, or make incredibly slow and difficult, the development of forest cover.

No account of the Downs would be complete without note of two interesting plants that have been introduced. The cloudberry or mountain bramble (*Rubus Chamaemorus*), at home in the Arctic, and on alpine summits of New England, was found between the Inn and Culloden Point on August 21, 1908, by Dr. William C. Braislin, who deposited specimens in the herbarium of the Museum in Brooklyn, since housed at the Brooklyn Botanic Garden. Diligent search has since failed to disclose this plant,

that at Montauk is hundreds of miles south of its true home. Migratory birds, known to make overnight flights from Labrador to Montauk, are supposed to be responsible for its introduction.

The other plant, probably introduced through human agency, is *Echinacea pallida*, found in 1914, and again in 1917, on the most exposed Downs, but by no means common. Its natural range is far to the westward on the plains of the middle west. Its rose-purple flowers nearly suggesting a single dahlia are very striking in their unfamiliarity at Montauk.

The Kettleholes.

The whole of Montauk Point is dotted with these depressions, some nearly a hundred feet deep, others mere swales, and the four largest covered with water, as discussed earlier. While the bottoms of none of the kettleholes, except, of course, the ponds, appear to be below sea-level, practically all the lowest of them has fresh water either near the surface, or, in the early part of the season, above it, forming a temporary pond, a few inches deep. The position of this water has a good deal to do with the vegetation, as will appear presently.

All of them agree in one particular, their sheltered seclusion from the wind in the bottom, often forming a welcome, if a warm haven for the summer tramper. The contrast between the bare wind-swept Downs and the bottoms of these kettleholes is tremendous. For details of the differences of the open Downs and the kettleholes, as sites for vegetation, see the section devoted to the wind in the chapter on "Factors of Control." So many of them are covered with trees and shrubs that casual visitors are inclined to think all of them are, which is actually far from the truth. Many are, some partially, others without a shrub or tree. While a general similarity in appearance seems to be true of those that contain woody vegetation, actually there are many variations, both in the species that occur in different kettleholes, and in the frequency of occurrence of those species that are common to all of them. Some of the deepest have considerable growth of the red maple or the sour gum, and in others that are not so moist, different species of oaks predominate.

If the forest is to be the ultimate covering of protected parts of Montauk, as it actually is now of Gardiner's Island, and, from historical records would appear to have been on at least some of the Point before disturbance by man, then those kettleholes that now have small editions of the forest in them are to be considered as more nearly approaching the climax condition than anything else on the Point. In other words, it should be possible to find gradations between kettleholes that have no trees or shrubs

to those that are full of them, and such early and late stages of development should be accompanied by at least some transitional stages.

A study of a good many of these kettleholes makes it seem probable that just these conditions are to be found today. Why some have been so delayed in their development as to show even at this late day

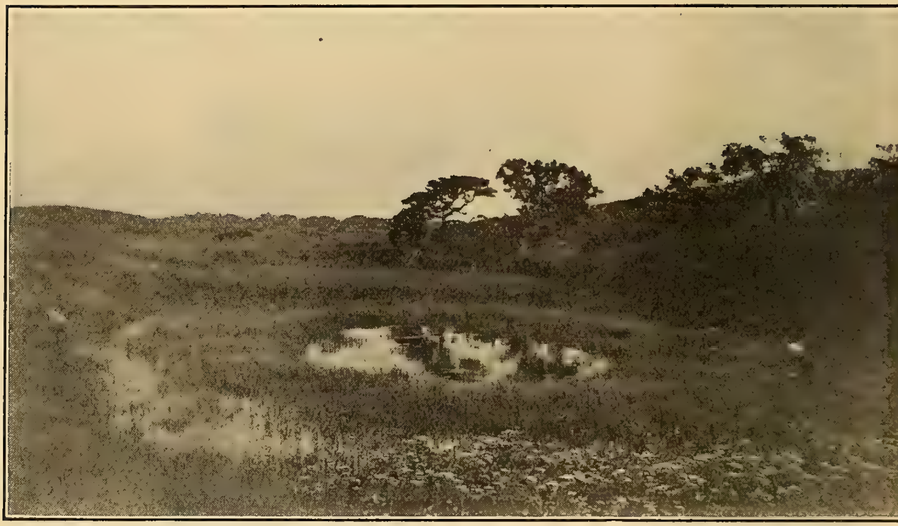


FIGURE 4. Pool in kettlehole near Culloden Point. Note amount of water and vegetation in it in September 1920, when this photograph was taken. In August, 1918, the water reached the edge of the kettlehole. See figure five for water-level in July, 1921. (Photograph by Barrington Moore.)

only the initial stages of it, is not very clear. In those where there is too much standing water, or where it does not recede early enough in the season, there is practically pond or pond-side vegetation that may be found over any part of Long Island. This is due to a too high and too steady water-table. Many other low kettleholes, however, have no standing water, and in practically all the cases where this has been observed the sides of the kettlehole (the Downs) come down very steeply, suggesting at once that material enough from these steep banks has filtered down to the bottom. This would not, of course, change the level of the water-table, but it would, and I think, has covered this over with silt a few inches deep in some cases and perhaps a few feet in the largest and most steep-sided of them. In contrast to this, the ponds that have been examined practically all have shallow banks, and it may well be that the presence or absence of standing

water is due to shallow or steep sides to the kettleholes. When it is remembered that no two kettleholes are topographically the same, few if any of similar depth, it is not surprising that a variety of conditions is to be found. There is, of course, one qualification to this statement regarding the presence of water in the kettleholes. Hundreds of shallow ones, too

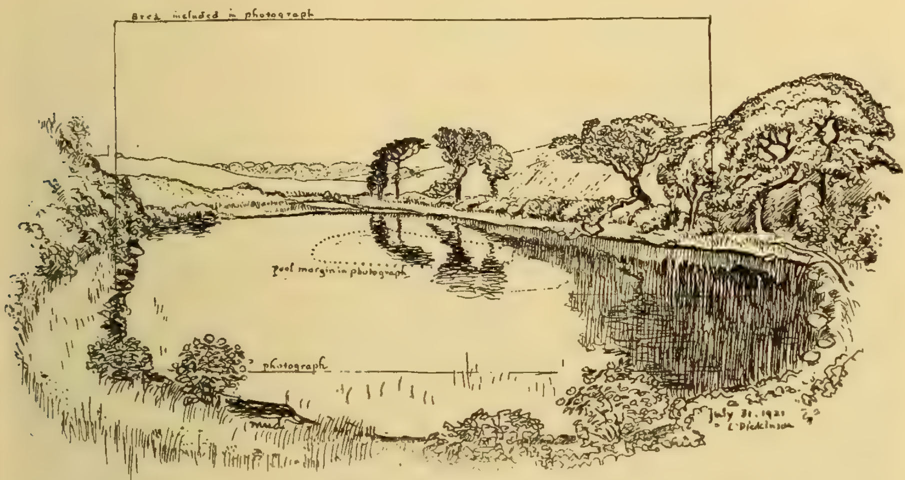


FIGURE 5. Pen and ink sketch contributed by Dr. R. L. Dickinson of the same kettlehole as shown in figure four. Note condition of water on July 31, 1921, when the sketch was made and position of water in September, 1920. In August, 1918, the kettlehole was filled with water.

near the tops of the Downs to be near the general watertable of the Point, have no water near their bottoms, and most of these contain no trees but stunted ones such as are found among the patches of "bush" described with the Downs. Some, also, of these upland kettleholes, often mere depressions, have only characteristic grassland vegetation in them.

Whether or not this be the true explanation of the presence or absence of water in the kettleholes, the fact remains that all low ones are in one of three categories: open water, seasonal ponds that dry by midsummer, or a water-table that is below ground-level.

The purely seasonal nature of many of these kettleholes is well illustrated by one of them between the Inn and Culloden Point. On August 13, 1918, the bottom of the kettlehole was filled with water. In September, 1920, the same place had, as the accompanying photograph shows (Fig. 4), less than half as much water. On July 31, 1921, the water had reached the same level as in 1918, well shown by the sketch (Fig. 5) kindly made of the

place by Dr. R. L. Dickinson on that day. He shows the relative size of the body of water in 1918, by indicating the position of it in the center of the pool. Such changes cannot fail to affect the speed of establishment and the composition of the vegetation.

FIGURE 6. Open stage of kettlehole. Center with *Eleocharis obtusa*. The white-flowered plant toward the margin is *Eupatorium perfoliatum*. Note shore lines of seasonal fluctuations of water level.

In those where water is fugitive or lacking at the surface, the following is presented after a study of many kettleholes in all stages of development.

LOW KETTLEHOLES: OPEN STAGE.

Low kettleholes without woody vegetation are still occasionally to be seen, but in all those examined there was standing water a few inches deep in early June, but practical dryness by midsummer.

In such kettleholes there are usually well marked zones of vegetation dominated by some characteristic plant, or assemblage of them, and in the one illustrated (Figs. 6 and 7) all the lowest and therefore wettest part of it was covered by *Eleocharis obtusa*. This small sedge is succeeded, towards

its edge, by a fringe of vegetation made up of the following species, the dominant ones first, and the others in the order of their frequency:

Gratiola aurea
Hypericum boreale

FIGURE 7. Details of marginal zone of vegetation in open stage of kettlehole. *Eupatorium perfoliatum*, *Steironema lanceolatum*, *Xyris flexuosa*, and *Gratiola aurea*, are among the commonest plants. Open Downs beyond.

Proserpinaca pectinata
  A mud form as found in September, probably a submerged aquatic when water is present.
Viola lanceolata
Persicaria pennsylvanica
Echinochloa Crus-galli
  A relic of grazing days? Native of Europe.
Cyperus dentatus
Scirpus debilis
Ilysanthes dubia
Juncus bufonius.

These ten species make up the bulk of the vegetation between the lowest part, occupied exclusively by *Eleocharis obtusa*, and the band of vegetation nearest the margin.

This marginal zone of vegetation occupies ground that, while well below the surrounding Downs, is high enough so that it is only covered by water for a short time in the spring. The plants here, therefore, do not suffer for water, nor are they smothered by it, as happens frequently in some kettleholes with uneven bottoms, or other conditions that permit too much standing water.

The vegetation of this marginal zone can best be shown by pointing out the dominant species toward the contact with the open Downs on the one hand, and toward the center of the kettlehole on the other, where it touches the zone for which the species have already been listed. In the following list of species the first and last are dominant nearest the inner and outer edges of the zone respectively. The others are arranged in order of frequency, reading from the top down for those nearest the inner edge of this marginal zone, and from the bottom up for those nearest the Downs. Toward the middle of the list are those species that are pretty commonly distributed all through this marginal zone.

Euthamia tenuifolia
  Dominant in that part of the marginal zone nearest the center of the kettlehole.
Steironema lanceolatum
  Often appearing dominant in midsummer from its wealth of conspicuous yellow flowers.
Gratiola aurea
Viola lanceolata
  Very often making large patches where it is locally dominant, but general and common through the lower part of the marginal zone.
Eleocharis tenuis
Rhexia virginica
Athyrium thelypteroides
Eupatorium perfoliatum
  One of the tallest herbs in the kettlehole.
Xyris flexuosa
Hypericum boreale
Juncus acuminatus
Stachys hyssopifolia
  Nearest the form known as *S. atlantica*

Ludwigia alternifolia
Cyperus dentatus
Scirpus debilis
Iris versicolor
Polygala cruciata
Lycopus americanus
Agrostis perennans
Glycine Apios
Oenothera muricata
Agalinis purpurea
Panicum virgatum

Dominant in that part of the marginal zone nearest the Downs.

These plants, with those already mentioned, make up, generally speaking, the vegetation of these low kettleholes that have no woody plants in them. The species in certain kettleholes differ somewhat, the individual frequency of the species even in the same kettlehole may differ in different years, but in dozens of them that are in this stage of development, the plants are mostly those indicated. One wide divergence from the type of a kettlehole in approximately this stage comes to mind not far from the Inn, where the bottom of the kettlehole is packed with *Decodon verticillatus* and *Hibiscus Moscheutos*, the Marshmallow, in about equal parts. Another, much nearer the Ditch Plain Coast Guard Station (see the map, Fig. 1) has exclusively *Hydrocotyle umbellata* in it.

In a few cases the first appearance of a woody plant is to be noted. In every case where only one shrub has been found it is invariably *Spiraea latifolia* or *Cephalanthus occidentalis*. These two bushes are certainly the pioneer ones at Montauk in populating kettleholes otherwise without woody vegetation. The appearance of either or both these bushes near the margin of a kettlehole does not, if, as often happens they are solitary or rare, change the general character of the place which is essentially a low, open kettlehole without woody vegetation. The appearance of woody plants in sufficient quantity to change, ever so slowly, the character of the kettlehole is an event of almost dramatic importance in the vegetation of the Point, and requires special mention.

LOW KETTLEHOLES: THE BEGINNINGS OF WOODY VEGETATION.

Many kettleholes at Montauk are in the condition just described, or are verging upon a still later stage in their development, when woody plants make a definite and apparently rather aggressive bid for occupancy.

Where this is pronounced the kettlehole may be found dotted with bushes, while in those just emerging from the purely herbaceous state, the few bushes found appear to be putting up a losing fight.

The permanent appearance of even a few bushes seems, in the kettleholes that have been examined, always to be associated with a lack of standing water, except perhaps in the early spring after the melting of snow. Whether the silting in of material from the banks is the true explanation of the disappearance of standing water or not, it is certainly true that in those kettleholes where water is fugitive or beneath the ground level, certain definite changes occur, followed by an encroachment of woody vegetation. The accompanying photograph shows a kettlehole in just this stage. A little water was found in it in June, none after. (See Figures 8 and 9.)

Its banks are very steep and the assumption that silted material has raised the floor of it enough so that shrubs will not smother from excess water, seems reasonable. It may also be that fires, which would scarcely affect herbaceous vegetation, would destroy pioneer shrubs in such places, thus greatly retarding the transition from an open kettlehole to a partially wooded one.

That there is always an orderly progression from open kettleholes to those about to be described, in which woody plants get a firm foothold, is probably not true. Some have been found where the process is arrested, due to unusually wet seasons or perhaps to fire, and one finds only dead shrubs, and a partial recrudescence of the purely herbaceous vegetation. But that this progression is going on, that bushes, and finally the dense wooded thickets of the climax type are ultimately developed, seems to be demonstrated.

The vegetation of a kettlehole of this developing type, where woody plants seem for the first time to have a firm foothold, is of interest, in view of the final stages to which it appears to point with rather definite directness.

As the photograph (Fig. 8) shows the center is dotted with dead clumps of *Scirpus cyperinus*, with here and there, in the higher places on the floor, a live one. Detailed studies of the remaining herbaceous vegetation in such kettleholes resulted in the following list of plants. The dominant species is given first, and in order of frequency, the others:

Triadenum virginicum
Gratiola aurea
Sium cicutaefolium
Lycopus rubellus
Onoclea sensibilis

Iris versicolor
Steironema lanceolatum
Juncus acuminatus
Scirpus cyperinus
Scirpus americanus
Persicaria hydropiperoides
Hundreds of tiny seedlings of this were also found creeping towards the center of the basin.
Eupatorium perfoliatum
Carex scoparia
Rhexia virginica
Ptilimnium capillaceum

There are sometimes other species found in kettleholes of this sort, especially large patches of *Aster novi-belgii* in some of its forms, but they are erratic and do not seem to occur with the regularity of those listed above.

A nearer photograph (Fig. 9) of the same kettlehole shows the arrangement and distribution of the shrubs among the assemblage of herbs mentioned just above. Towards the center of the kettlehole all the bushes are *Cephalanthus occidentalis*, whether dead or alive. As the photograph shows some are dead, due often to water smothering, which may sometimes occur in the center of the kettlehole even after bushes have gotten a foothold. Towards the edges of the kettlehole, and in addition to the dominant *Cephalanthus occidentalis*, four species of bushes entirely new to the kettleholes are found in considerable profusion. Of these *Rosa virginiana* is the commonest, *Rubus frondosus* next, and much more rarely *Vaccinium corymbosum*. Occasional plants of *Ilex verticillata* are found and, nearly on the edge of the Downs, *Spiraea latifolia*, which as we have seen is also found in kettleholes otherwise entirely without woody vegetation. These shrubs, and often *Eupatorium perfoliatum*, are often intertwined with *Convolvulus repens*, also a new plant in such developing kettleholes.

In a kettlehole southeast of the Inn toward the upper end of a deep gully that runs easterly from the road from the railway station to the site of the aviation camp (Great War 1917–1918), a curious variation of the encroachment of woody plants is to be found. The kettlehole is steep-sided and, in the early summer covered for at least a foot by water with a specific acidity of 30+. There is a marginal fringe of *Clethra* and *Ilex verticillata* neither of which is common, but the center of the kettlehole is full of *Cephalanthus occidentalis*. This is unquestionably a later stage in succession than those previously noted.

Kettleholes in this stage of development give an entirely different aspect to the landscape from those that have already been described, where low herbaceous plants predominate. The advent of shrubs, which is followed, of course, by trees, can be interpreted only as one more step in that process

FIGURE 8. General view of the beginnings of woody vegetation in low kettlehole. For details see text and Figure 9. In the foreground the dominant Downs grass *Schizachyrium scoparium* comes right down to the edge of the kettlehole. The white flower is *Eupatorium perfoliatum.*

of final woody covering going on very slowly, it is true, but none the less surely. The final stage or climax of the vegetation is found in the densely wooded, mysteriously dark and silent kettleholes, popularly supposed to be malaria-ridden, and into which few care to penetrate. These heavily wooded kettleholes are so much more conspicuous than the others that

have been noted that they attract more attention and are often assumed to be the characteristic condition of all kettleholes. The preceding account will have failed of its purpose if it is not now understood that these conspicuous wooded kettleholes are themselves the result of the development

FIGURE 9. Details of figure eight. Clumps of *Scirpus cyperinus*. The shrubs are mostly *Cephalanthus occidentalis*, and *Rosa virginiana*, more rarely *Vaccinium corymbosum* and *Spiraea latifolia*.

of the vegetation from the pioneer, and easily exterminated assemblages of plants found in kettleholes with long-standing or fugitive water, through a somewhat tentative woody stage to a climax of relatively permanent trees and shrubs with their associated herbs.

LOW WOODED KETTLEHOLES.

Dense masses of trees and shrubs, hopelessly tangled with Smilax, or Poison Ivy, or Virginia creeper,—this is the first impression one gets of the bottoms of most of the kettleholes at Montauk. Many of these are practically impenetrable without considerable cutting, and all of them are "cut off" by the wind. So universal is this action that many of the kettleholes appear to have their trees pruned or treated as a landscape architect might do for a definite effect. Trees and tall shrubs, such as the poison

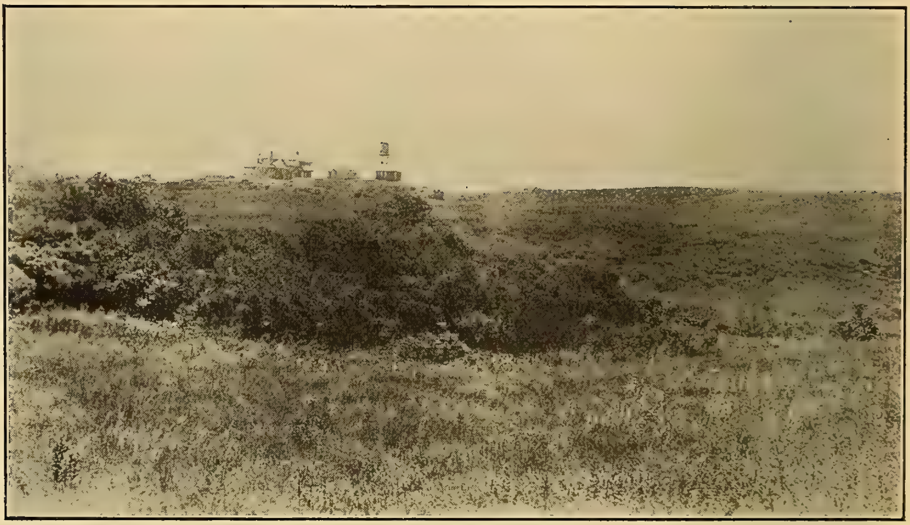


FIGURE 10. General view of wooded kettlehole at Montauk. (Photograph by Barrington Moore.)

sumac for instance, reach varying heights, depending on the depth of the kettlehole, which brings their tops just under the range of the wind that constantly sweeps above them. This often gives a wind-wrenched appearance to many trees, and very old specimens have a remarkably ancient and sturdy aspect, as though everything possible had been done to break through that impassable barrier, the depressing effect of which is so noticeable, and from which the depths of these wooded kettleholes provide the only real refuge.

Another feature of these wooded kettleholes that attracts attention is the sharp contact between them and the open Downs. The accompanying

photograph (Fig. 11) well illustrates this, which is characteristic of those wooded kettleholes that have consistent topography,—that is, where the moisture conditions are uniform enough to allow of practical similarity of woody vegetation, quite up to the edge of the Downs. In some, spurs of the kettlehole, with a higher level than the general floor, extend out into the surrounding Downs. In such cases the contact is obscured, and typical thicket vegetation replaces either type. This condition is not so common as the one illustrated which is characteristic of scores of the kettleholes at Montauk.

While the general aspect of these kettleholes is so uniform, and while, in the sequel, a list of their characteristic species will be given that is very generally typical many curious interlopers are to be found in some of them. If all the kettleholes at Montauk, probably some hundreds, could be studied as closely as the ones that have resulted in this account, there is little doubt that more species would be added to those known from the region. It is a commonplace, however, that the discovery of such would not in the least change the general aspect of the vegetation, nor the development of it to this climax. And it is because of this developmental phase of the vegetation, more than the discovery of a species new to the Point, that so much time has been spent in a description of it.

The characteristic species of these densely wooded kettleholes are given below. Under Trees, Shrubs, and Herbs, the dominant species is given first, and then the others, in order of their frequency:

Trees

- Acer rubrum
  - The form more nearly approaching *A. carolinianum*.
- Nyssa sylvatica
  - This and the red maple are dominant in practically all the low kettleholes.
- Amelanchier intermedia
  - Frequently twenty feet tall and with trunk three inches in diameter.
- Crataegus pruinosa
- Fagus grandifolia

The last two are rare, and from the point of view of frequency, the first two are the significant species, as they dominate and give character to the kettlehole. Because of the depressing effect of the wind, the crowns of all these trees and the shrubs to be mentioned presently, are much congested and the canopy of foliage is thus so dense that it is almost dark in the interior. Some idea of the darkness may be realized by recording the

fact that in the heart of some of the largest of these wooded kettleholes there is no ground vegetation at all. This lack of herbs and their flowers merely accentuates the deep gloom of these dense stunted little forests. In the center of them one finds only the heavy canopy of foliage just overhead, and the dank carpet of dead leaves under foot. The accompanying

FIGURE 11. Sharp contact between edge of wooded kettlehole and open Downs. The flower on the Downs is the beautiful little purple-flowered gerardia (*Agalinis acuta*).

photograph (Fig. 12) gives some idea of the tangle of shrubs and trees in one of the wooded kettleholes viewed from the inside.

Shrubs

Amelanchier intermedia (bush form)
Aronia atropurpurea
Clethra alnifolia

Azalea viscosa
Viburnum venosum, and much less frequently *V. dentatum*
Sambucus canadensis
Rosa palustris
Vaccinium atrococcum
Ilex verticillata
Padus virginiana Mill. (Prunus serotina Ehrh.) as a shrub.
Toxicodendron vernix

FIGURE 12. Interior view of wooded kettlehole. For details see text. (Photograph by Barrington Moore.)

These with the trees mentioned above, form next to impenetrable growths through which it is almost impossible to force one's way. It often happens that their branches are inextricably bound together by vines of *Smilax rotundifolia*, *Vitis aestivalis*, *Parthenocissus quinquefolia* and *Toxicodendron radicans*. The difficulty of getting through them, coupled with the almost funereal gloom of their interiors has made these wooded kettleholes an object of suspicion among some of the natives, and even among more sophisticated visitors.

Herbs

Toward the center, very often none.

Unifolium canadense
Uvularia sessilifolia
Osmunda claytoniana
Dryopteris noveboracensis
Boehmeria cylindrica
Iris versicolor (in deep shade)
Impatiens biflora
Eupatorium verbenaefolium
Galium Claytoni
Aster cordifolius
Arisaema triphyllum
Fragaria virginiana
Euthamia tenuifolia (toward edges)
Aster multiflorus
  Not at all like the form found on the Downs. These protected plants frequently 3 feet tall.
Viola cucullata
  Toward edge of kettle hole; rare
Solidago serotina
Aster novi-belgii
  In addition to the typical form others are found to which varietal names such as *elodes* and *atlanticus* have been applied.
Aster spectabilis (toward edges)

In many of these wooded kettleholes *Rubus hispidus* is very common as a ground cover and, except at the center, is very likely to run in and out among the stems of other plants, increasing the difficulty of walking. Dark moist places in these kettleholes are often carpeted for square yards by the beautiful feathery moss *Climacium americanum Kindbergii*. Of course, at the actual contact of the herbs of the kettlehole and the Downs there is nothing like such a sharp line as the photograph shows for the woody plants. There is often some encroachment of the Downs' herbs, in usually much changed form, into the kettlehole.

All wooded kettleholes are not of this type, as some with higher elevations have oaks predominating in them, but even in these the red maple and sour gum are often found toward the center. The shrubs and herbs are much the same in all wooded kettleholes, but the lists given by no means tell all the story, for occasional species are found in many kettleholes and nowhere else on the Point. *Ranunculus delphinifolius* is one for instance. The discovery of others is practically certain as the kettleholes vary a good deal in depth, in the configuration of the surrounding Downs, and in

exposure where there is a break in these, and in other particulars. The main fact of significance seems to be that the wooded kettleholes exhibit a climax condition of the vegetation, comparatively stable so far as changes are concerned, and in this respect unlike any of the vegetation types thus far dealt with. For we have seen that the most protected parts of the Downs may become invaded ultimately by patches of bush, which themselves sometimes lead to higher bushes and possibly, but rarely, to stunted trees. Where there is protection from wind this may result in considerable areas of scrub or forest. This has happened, notably toward Gin Beach, a region near the north (lee) end of Great Pond. Here there are considerable areas of stunted oak woods that appear to have started in the method suggested in the preceding paragraphs.

Most of the kettleholes at Montauk could probably be sorted into the different categories that have been described, or into easily recognizable variants of them. One or two curious exceptions are interesting, however.

In an upland kettlehole between the Inn and Culloden Point there is practically no Downs vegetation, but the floor of it is packed with *Triosteum perfoliatum*, interspersed with a thicket-like growth of *Euthamia tenuifolia*, *Solidago rugosa*, *Panicum clandestinum*, *Asclepias syriaca*, and an occasional bush of *Rosa carolina*. *Triosteum perfoliatum* besides this Montauk record is known only from a rich woods at Orient, then not for a hundred miles to the west and again in rich woods which is its usual habitat. Its occurrence in such profusion in this upland kettlehole, only just out of range of the wind, and in full sunlight, is curious.

The other kettehole is Great Pond, near the north end of which there is an island. This is just above the water level of the lake and contains the tallest trees at Montauk. In fact the appearance of this densely wooded island suggests an unbroken occupancy by the forest. The forest floor here is quite like that of other forests, and not at all like the undergrowth of the wooded kettleholes already described. Because of these conditions a list of the plants found there is given:

Quercus coccinea
Quercus alba
Quercus velutina
Quercus rubra
Hicoria sp.
Amelanchier sp.
Viburnum venosum
Corylus americana
Hamamelis virginiana

Cornus alternifolia
Sambucus canadensis
Benzoin aestivale
Parthenocissus quinquefolia
Vitis aestivalis
Toxicodendron radicans
Aralia nudicaulis
Pteridium aquilinum
Vagnera racemosa
Geranium maculatum
Syndesmon thalictroides
Phryma Leptostachya
Lysimachia quadrifolia
Scrophularia leporella
Solidago altissima
Solidago rugosa
Mariscus mariscoides
Pluchea camphorata
Hibiscus Moscheutos
Phragmites Phragmites
Typha angustifolia

FIGURE 13. Lee contact of Hither Woods and open Downs. Note the vanguard of pioneer oaks creeping out from the edge of the forest, and, for comparison, the abrupt edge of the ordinary wooded kettleholes (Fig. 11).

THE HITHER WOODS.

If other evidence as to the gradual afforestation of some parts of Montauk were lacking there would still remain the Hither Woods, and its eastern or lee contact with the Downs, to confirm the point. Nowhere else on Long Island is there such a splendid illustration of the encroachment of a forest over the grassland as at the northeasterly contact between these woods and the Downs, about a mile west of the village.

The Hither Woods, predominantly oak, present an extraordinary appearance when compared with other forests on Long Island. The woods extend for about four miles west of Montauk and they are dense. Apparently they have always existed, since the earliest record of the first settlers at Easthampton speaks of them. J. A. Ayres who visited the

region in 1849 wrote then of woods at Montauk, as follows: "There are two tracts of woodland, known as "the Hither Woods," and "the Point Woods." Solitary and decaying trunks over all the country show that not many years since it was covered much more extensively and perhaps wholly with forest."

There is all the appearance today of great age for certainly the trees look very old. Many times they are not over forty feet tall, so that it is not their height that suggests age. Festooned as many of them are by lichens, and the forest floor under them often carpeted with *Cladonia furcata racemosa,* they stand "like the druids of eld," clad in the misty grayness of antiquity. The frequency of trees that have toppled over as they died, and lie rotting on the leaf-carpeted ground—all these, with the undisturbed look of the place, give one just such an impression of long occupancy for this forest, as the historical records indicate.

While the woods are thus a striking feature of the landscape, it is their lee contact with the open Downs that is of chief interest in considering what is the role of this forest in the vegetation history of the Point. So that we can better understand the composition of this forest, and as a record of what sort of growth it is that seems to have such an aggressive fringe, the following list is submitted. The species are arranged under Trees, Shrubs, and Herbs, and under each of these groups the species are listed in the order of their frequency.

Canopy trees
- Quercus velutina
- Quercus alba
- Quercus coccinea
- Quercus rubra (rare)

Undergrowth
- Kalmia latifolia } dominant
- Gaylussacia baccata } dominant
- Sassafras Sassafras rare, only young plants seen
- Padus virginiana
- Vaccinium angustifolium
- Ilex opaca
- Amelanchier canadensis
- Amelanchier nantucketensis
- Parthenocissus quinquefolia
- Smilax rotundifolia
- Vaccinium vacillans, frequently with *V. angustifolium* making large exclusive patches

Undergrowth
- Herbs
  - Aralia nudicaulis
  - Epigaea repens
  - Melampyrum lineare
  - Trichostema dichotomum
  - Chrysopsis mariana
  - Aster patens

FIGURE 14. Pioneer oaks going out over the Downs from the lee side of Hither Woods.

  - Solidago bicolor
  - Carex pennsylvanica
  - Danthonia spicata, mostly in openings
  - Crocanthemum canadense
  - Crocanthemum dumosum

The foregoing gives a fairly complete idea of the composition of the Hither Woods near the edge of it, and the same general condition is found some mile or more west of the contact. Quite unlike the contact between the low wooded kettleholes and the Downs, which is very sharp, the Hither Woods–Open Downs contact on the eastern edge is by no means so, as our illustrations show (Figs. 14 and 15). There is in fact so much penetration of the Downs by these pioneer woody plants that just at this point there seems unfolding before us a bitter struggle for supremacy between these different types of vegetation, and the grassland is putting up the losing

fight. The evidence of this contest for new land, as it comes to that in the case of the trees, seems clear enough and to illustrate it, a section extending from pure grassland (east) to pure forest (west) has been studied in considerable detail. Because topography is such a vital factor in supplying shelter from the wind a rough cross-section of the hill is given to show the conditions at the point the section was taken.

Beginning at A (Fig. 15) the top of the bare Down, there is much the same condition as that noted under the general description of the Downs,

FIGURE 15. Diagrammatic section from the Hither Woods (west) to the bare open Downs (east), about 1 mile west of Montauk Village. The hill at A is about 50 feet high.

A. Bare Downs, with herbs and scattered clumps of stunted bushes.

B. Tension zone with occasional Oaks and much greater profusion of shrubs which are taller than at A.

C Edge of Oak forest at the Hither Woods For associated shrubs and herbs under these trees see text.

but with this difference. Here there are more numerous and larger patches of stunted bushes, and these are not of the species there described. Two of these new shrubs are interesting as being common bushes and of normal height a short distance away in the protection of the Hither Woods. At A, however, both *Comptonia peregrina* and *Gaylussacia baccata* are not over eight inches high, and frequently they make patches 30–50 feet across. That these and *Amelanchier canadensis* have "escaped" from the Hither Woods onto these open Downs, seems a conclusion almost axiomatic. All of them, and other woodland species, to be noted presently, have been found on the Downs only at this contact with the Hither Woods.

These three shrubs, with their associated plants, serve as pioneers for the serious invasion of the grassland by the forest. On the top-most part of the Downs these three shrubs are found only in rare patches. But as one goes down the hill toward B they increase in size and frequency tremendously, merging finally at C with their more usual prototypes that occur in and along the edge of the Hither Woods.

The interlacing of these two elements along this contact makes one of the most interesting features of the vegetation of Montauk. On the top of the hill, A, are mostly bare Downs with quite typical Downs species. Then as one gets closer to the woods there is the progressive disappearance of true Downs species, the flourishing of "escapes" or pioneers from the woods, overtowered presently by the vanguard of the oaks, for which, in a sense, they have been preparing the way. It is, of course, not such a simple matter as the ease of description might indicate. Many local irregularities, such as breaks in the Downs, exposure to the winds and so forth may arrest this process or modify it. In fact along certain places, where the Hither Woods is close to and exposed directly to the sea winds these stragglers from it out into the Downs are practically unknown, as we shall see presently. But where there is even slight shelter there is always the condition that has been noted.

At and near B (Fig. 15) where the struggle between the Downs' plants and the pioneers from the woods is most intense the following plants were found, arranged in order of frequency. Those that are of the Downs contingent are in *italics*, while the Hither Woods element is printed in bold face type. A few plants of general distribution over Montauk, or of no special significance in the struggle for occupancy are in ordinary type.

Gaylussacia baccata
Rubus flagellaris
Comptonia peregrina
Agrostis alba
Deschampsia flexuosa
Rhus copallina
Asclepias amplexicaulis
Schizachyrium scoparium
Padus virginiana
Amelanchier nantucketensis
Aster patens
Euthamia tenuifolia
Chamaecrista fasciculata
Rosa palustris

Anaphalis margaritacea
Chrysopsis falcata
Crocanthemum majus
Moehringia lateriflora
Myosotis virginica

In certain places at the bottom of this slope there are large, practically exclusive, growths of *Comptonia peregrina*. Over a considerable part of

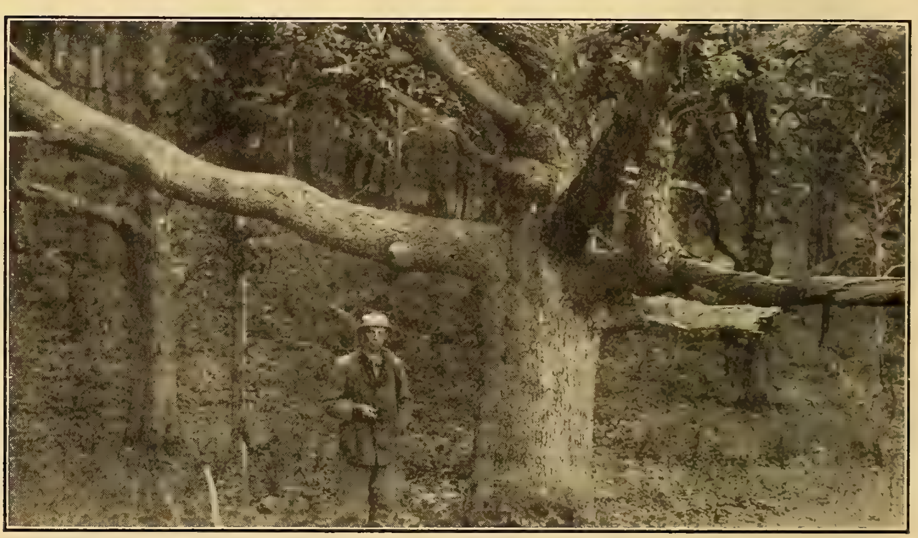


FIGURE 16. Open grown specimen of black oak (*Quercus velutina*) at the edge of Hither Woods, three feet in diameter at breast height. (Photograph by Barrington Moore.)

this area there is an impenetrable tangle of *Rubus procumbens* scarcely over three inches tall and a conspicuous inhabitant of the patches of bush over the rest of the Downs.

Among the miscellaneous growth, made up of elements from the Downs and the woods, and both actively attempting to appropriate the ground, there is evidence that the pioneers from the woods are winning. The most convincing features of this aggressiveness of the woods' plants are the numerous oaks which push out from the woods and find at least sufficient congeniality to persist in this tension area. Everywhere where the conditions produced by pioneer plants from the woods have made the escape of these oaks possible, they are sure to be found. This aggressive expansion must end in a considerable curtailment of the Downs area ultimately.

The oaks reach really exposed places toward the tops of the Downs only rarely, and with apparently great difficulty. But as in many other things, nothing succeeds like success, and once the start is made, it seems only a matter of time, due to increasing protection from the wind as the growth becomes gradually thicker, when the open Downs itself will be inundated by this ever encroaching woody invasion, infinitely slow as time goes, but from all the evidence available, as certain as the tides. Just how fast this is going on only a study over a series of years would show. But it does seem as though this contact between the Hither Woods and the Downs was perhaps the most energetic of all the different types of vegetation that seem to have as their common goal the afforestation of parts of the Montauk Peninsula, if that is climatically and edaphically possible.

There are some hints as to the rate of this encroachment of woods over grassland. About 400 feet west of the present contact with the open Downs, and in the midst of the dense shade of surrounding oaks is a dead *Juniperus virginiana*, which appears to have died within the last ten years. Increment borings show it to be at least eighty years old when it died, and adding ten years since death gives us about 90 years since it was a seedling.

This could hardly have started in the shade of the forest, and would, if it followed ordinary procedure, have started out in the open, or more likely still, in the area that then corresponded to the present fringe of the forest. Since that time the forest has gone out over the Downs about four hundred feet, submerging and ultimately killing the cedar. In other words, the evidence from this dead cedar would indicate a rate of forest movement of 400 feet in about 100 years.

Atthe present contact, but quite out in the open, and perhaps 100 feet from the forest edge, there are scattered young oaks, as shown in the photograph (Fig. 14). One, a *Q. velutina*, 14 feet tall, 6 inches in diameter, proved by core extraction to be 15 years old. By no means all the area between it and the edge of the woods, is yet occupied by pioneers from the forest, so that in the 15 years since it started there has not been any great speeding up of the process.

There is also other evidence, from the oaks themselves, that the Hither Woods have not always been as extensive as they now are. Many trees, particularly near the margin of the woods, show unmistakable evidence of having, in their young stages at least, developed in the open. The accompanying illustration (Fig. 16) shows a branching system that no forest grown specimen of oak could have produced. We could, from this evidence alone, say that most certainly the Hither Woods are spreading wherever possible, and that the branching of nearly all the oaks that have been

observed near the edges of the woods confirms the point. True forest-grown specimens of oaks are found only toward the center of the woods or in hollows.

The evidence along the eastern edge of the Hither Woods that they are gradually spreading still more eastward seems conclusive to the writer,

FIGURE 17. Wind clipping at the edge of the oak forest on the windward side of Hither Woods. Photo January, 1923.

and the explanation also appears to be indicated that this encroachment over the grassland can be accomplished only to leeward, which means generally to the eastward. Perhaps the best illustration of this wind control of the invasion of grassland by woods is furnished by the south side of the Hither Woods at Montauk. Facing the sea, they are subject to the violent southwest winds of summer, and the forest wall is abrupt (Fig. 17). No

vanguard of pioneers spreads out over the grassland for on these exposed Downs no pioneer can stand up.

Whether the violence of this wind is actually reducing the size of the forest only marked plots studied over a series of years would prove. The present site, and probably the general extent of the Hither Woods has existed from very early days, as David Gardiner, in his "Chronicles of the Town of Easthampton" writes of the early condition of the country thus: "To the east of this [Napeague] was Montauk, a high and hilly region of rich land, where resided the tribe of that name, over whom Wyandanch exercised control. Along the whole sea coast of the town, the border of the upland produced a scrub oak, but the trees being gradually protected by each other, from the violence of the winds which reached from over the wide spread ocean, enlarged in height and size as they receeded. The oaks were the predominant tree; they were of large growth, and, in the openings, of very extended branches."

There are, however, numerous historical references to the diminution of these woods, none of which are of any real value, as none that has been seen are for marked plots. It is certainly true at the present time, that on this southern side, there is no attempt worth mentioning of the forest to creep out over the Downs, such as we have seen it do on the more or less protected east side.

About half way from their western end, not over half a mile from the beach, the contact is very abrupt. The woods at this point consist of *Quercus alba* and *Q. coccinea* dominant, with a small mixture of *Padus virginiana*, *Hicora sp.*, and a few shrubs such as *Rubus nigrobaccus*, *Rhus copallina*, *Rosa virginiana*, and *Gaylussacia baccata*, tied together with Virginia Creeper, *Smilax glauca* and *S. rotundifolia*.

The herbs and other undergrowth under this forest, which is about one-half the usual height, although obviously mature as evidenced by the old trees that fall naturally, are the following, arranged in order of frequency.

Lysimachia quadrifolia
Rubus hispidus
Deschampsia flexuosa
Solidago rugosa
Aster ericoides
Nabalus trifoliolatus
Acalypha virginica

Just beyond are the open Downs with vegetation typical of such places. In them only a rare white oak seedling is to be found, usually not over a foot high, its few leaves browned and wind-scorched. Stragglers from the forest such as *Gaylussacia baccata* and *Rubus nigrobaccus*, mixed with such

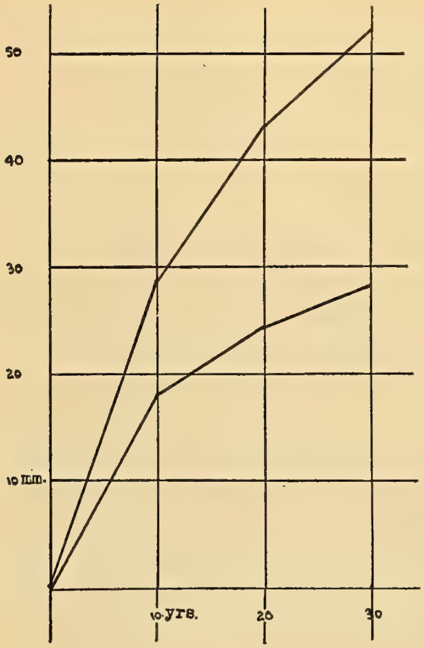


FIGURE 18. Rate of growth of the scarlet oak (*Quercus coccinea*) on the windward and leeward sides of the Hither Woods, expressed in increase in mm. of diameter at each ten year period. The hardness of the wood prevented deeper increment borings than are indicated. Upper curve an average of 20 trees on the leeward side; lower, of 20 on the windward side.

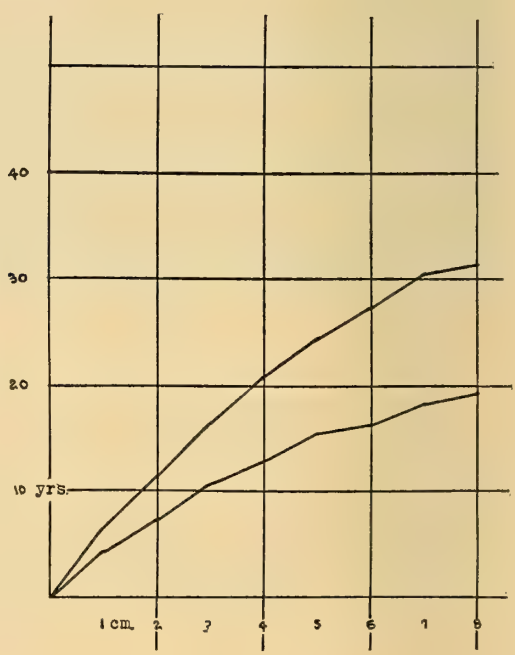


FIGURE 19. Age in years at each cm. of diameter growth of the scarlet oak (*Quercus coccinea*) on the windward and leeward sides of the Hither Woods. Upper curve = wind ward side, lower curve = leeward side.

typical Downs shrubs as *Myrica carolinensis* make small patches of "bush," but conditions for invasion by trees, are so much more severe than at the east end, that they present a practically impassable barrier to forest encroachment on this windward face.

In attempting to get more direct evidence of the effect of the wind on the growth of the scarlet oak on the windward and leeward sides of the Hither Woods, borings in many trunks were made. The cores so extracted in each case came from trees about twelve inches in diameter. Those taken from trees on the windward side of the woods were all taken in the direction of the wind, to overcome any irregularity, by averaging, that might result from the effects of the wind on eccentricity.

On the leeward side of the forest the trees average 28.8 mm. diameter growth in the last ten years, as against 18.4 mm. during the same decade on the windward slope. For the ten years previous to this the scarlet oak averaged 43.1 mm. in the lee and only 24.3 mm. where exposed.

To put the case in another way, it took the trees in the lee and those exposed to the wind very different periods in which to develop similar girths, if, indeed the exposed trunks will ever catch up with their better protected brethren. The accompanying charts (Figs. 18 and 19) show their growth curves and relative rate of growth graphically.

The Region East of Great Pond ("The Point Woods")

As we have seen, the wind seems to be the chief factor in checking the spread of woody plants, first in the open Downs, where the patches of bush are at first small and weak, then in the kettleholes, where, if they are not low enough to be within reach of water and at the same time out of reach of the wind, their woody vegetation is sparse; and lastly, along the edge of the Hither Woods where initial attempts of the trees to really capture outlying bare Downs are stopped or retarded by the wind. It might readily be supposed that if there were a place at Montauk where protection from wind was perfect, or at least greater than elsewhere on the Point, this should exhibit quite other types of vegetation than those already described. That there is such a place and that it does have an entirely different aspect from anything else at Montauk will be sufficiently clear from the following.

From Prospect Hill to the Point there is a long stretch of country which, at least to the south, is more or less in the lee, so far as west and southwest winds are concerned. All along the sea from just east of Ditch Plain to the

Lighthouse there are high bluffs rising from the sea sometimes as much as 75–100 feet, which is a considerable height for Montauk. There is thus a large area more or less in the lee stretching from east of Prospect Hill to the Lighthouse and from just back of the coastal bluffs more than half way to the shore of Gardiner's Bay. Not all of this area is covered with shrubs and trees, but the better part of it is. So dense is the growth in many places that it is practically impenetrable. Trees up to thirty feet are common enough in the lower parts of this region and only on the very top of some of the highest Downs is the expected grassland vegetation found. The density of the growth, diversity of the species found there is immediately noticeable to the casual traveler, after he leaves Great Pond to go toward the Lighthouse. Where before one has been traveling over little more than easily diverted trails over the grassland, from where the woods begin to the Lighthouse, the road winds in and out among hills, it is true, but here they are mostly covered with a dense growth of woody plants. No very careful study has been made of this region, the largest in area and probably the richest in species of plants at Montauk. One reason for this is the difficulty of getting about, and the other is that here the process of forestation is so far along that there is not the interest as in other parts of Montauk, where, as it were, things are in the making, rather than as at this place, they are very nearly made over. It is only because of the wind, which, while considerably reduced in its action, is by no means impotent, that this woody growth at Montauk Point is not higher. It may well be ultimately as high as the forest on Gardiner's Island, and before the great storm of 23 September, 1815, it was said to be so. (See the section on climate in "Factors of Control.")

As a record of what has been observed in these woods at Montauk Point, which as here defined means the region from Prospect Hill and the cottages east of Ditch Plain to the Lighthouse, the plants peculiar to or characteristic of the Point have been so designated in the list of plants of Montauk, which is the final section of this sketch.

No mere list of species, however, would convey an idea of the heavy growth of shrubs and trees in this region of Montauk. The trees are mostly as large as at Hither Woods, but the diversity of environment, for there are several ponds, bogs, and swamps, is such that the number of different species is greater than all other parts of Montauk combined. In the boggy places, about the end of May this part of the peninsula is aflame with *Arethusa bulbosa*, in fact it is more common here than elsewhere within the observation of the writer.* It is here too that *Kneiffia Allenii*, a plant

* Mr. Edward S. Miller, who with H. W. Young, wrote a "Catalog of the Plants of Suffolk County," in 1874, and who lives at Wading River, reports that *Arethusa* is probably more common in the bogs north of Manorville, than anywhere else on Long Island.

long thought to be endemic at Montauk is most common. *Viburnum venosum*, a rare shrub, is also found here in the thickets and is by no means scarce. In these woods too are found the common columbine, *Aquilegia canadensis*, so common in the rocky places in the region north of New York, but on Long Island exceedingly rare at a few other places on the north shore.

Within this region too is the finest growth of the Mountain Laurel known to occur on Long Island. Plants up to 20 feet, with stems three inches in diameter are to be found by diligent search, an exact locality for which prudence would not advocate divulging.

Perhaps the culmination of what the vegetation of Montauk will do, if partly protected from the wind and given adequate water supply, is to be found near the center of these woods. Here one may find as nearly typical a Beech-Maple climax forest as can be found anywhere else on eastern Long Island, except at Gardiner's Island. Neither at Montauk, nor, elsewhere on Long Island, is there a true representative of the Beech-Birch-Maple forest type, so common over great areas northward.

None of the trees is over forty feet tall, however. Mixed with the beech and *Acer rubrum* are scattered *Nyssa*, *Quercus rubra*, *Quercus alba*, *Hicoria glabra*, *Ilex opaca*, and *Hamamelis virginiana;* the last two the largest of any specimens seen on Long Island, nearly thirty-five feet high. The Witch-hazel here has a maximum girth of twenty-one inches.

Through these trees meanders a sluggish stream flowing towards the north, its shaded waters crammed with *Vallisneria spiralis* intermixed with *Fontinalis Novae-angliae*. Along the shallowest of its banks are zones of *Arisaema triphyllum* or *Spathyema foetida*, among which, or on somewhat higher sites are masses of *Viola pallens*, *Viola cucullata*, and *Thalictrum revolutum*. Other herbs scattered through the lowest part of these woods are *Osmunda cinnamomea* and *Athyrium Filix-foemina*, which are rare, and *Vagnera racemosa*. Somewhat above this lowest level, there is a zone of herbaceous vegetation almost completely dominated by *Anemone quinquefolia* and, scarcely less so by *Trientalis borealis*. Almost no shrubs are found at this point, only *Benzoin* and *Sambucus canadensis*, surviving the dense shade of these woods.

All along the north side of these woods the region is very nearly typical Downs, such as that described earlier in this account. One difference, however, is that in this region near the Point there is so much low land and the substratum is sufficiently acid, that cranberries are more plentiful than in almost any other part of Long Island. This has been true for over a hundred years as the following, from the town records of Easthampton of

April 7, 1789, shows: "Voted and agreed on by major vote, on the day above-said, that if any person or persons shall and doth rake, pick or any other way gather any cranberries on any of the lands or meadows belonging to the proprietors of Montauk or the town commons at any time before the second Tuesday in October next, ensuing at sunrise, he, she, or they so offending shall forfeit and pay the sum of eight shillings, current money of New-York, per bushel, to be recovered before any Justice of the Peace in and for the county of Suffolk."

There are, of course, many commercial cranberry bogs on Long Island, notably in the region between Manorville and Riverhead that are larger than any at Montauk. But as wild growths, the Montauk bogs are the most extensive.

In this region there is a curious relic of introduction in a large grove of *Ailanthus* trees at the southeastern edge of Reed pond. It comprises at least three acres and the trees are vigorous. Borings from their trunks indicate approximately even age which appears to average about sixty-five years.

FIGURE 20. Wind wrenched specimen of the sour gum (*Nyssa sylvatica*) with an Osprey's nest. (Photograph by Barrington Moore.) See also figure 17.

FACTORS OF CONTROL.

THE CLIMATE.

The most active determinant in the recent development of the Montauk vegetation appears to be the wind, of which there is a greater movement there than at any other point on the Atlantic coast.* Indeed the wind is so terrific, of such long-continued gale force, that after a few visits one is apt to think that the wind is the only factor controlling the present distribution of the vegetation.

While there is no weather station at Montauk, the figures for Block Island, which is sufficiently close [16 miles] to warrant the statement that the conditions are about the same, have been studied. An average over a period of years shows that the total wind movement at Montauk (Block Island) is 155,975 miles per year. This is nearly double that of the middle of the Island, the nearest Weather Bureau station for which is New Haven, and which shows an annual wind movement averaging slightly over eighty thousand miles. In other words, the wind blows twice as much at Montauk

* It should be said that Sandy Hook is a close second to Montauk, perhaps because of the funnel-like action of the Hudson Valley, in conjunction with the normal sea breezes.

as it does at Port Jefferson, for instance. During many months the wind movement at Montauk averages thirteen thousand miles (about six thousand at Port Jefferson) and hourly velocities of 60, 65, 72, 74 and 80 miles are not uncommon, while the wind has been known to blow as much as 84 and 86 miles an hour during severe storms. The high record at Port Jefferson is 61 miles an hour.

Another feature of the wind at Montauk, surpassing all other stations along the Atlantic coast, is that there average 109 separate winds in each year, of over fifty miles an hour velocity. Even comparative periods of calm, punctuated by such gales, must have a profound effect upon the vegetation.

These separate winds that blow over fifty miles an hour come more frequently, of course, during the winter months. Eighty of them come during December, January, February and March, while the others are scattered through the rest of the year, June and July excepted, which appear to be, on the average, free from them. The scarcity of evergreens,—there is only a single stunted pitch pine, and very few cedars,—may well be due to the bunching of these winds during a period when, unlike deciduous trees, their transpiration demands are most difficult to meet.

Most of these figures of wind movement are taken from an article by Spencer Lee Trotter on "Local peculiarities of wind velocity and movement along the Atlantic seaboard,—Eastport, Me., to Jacksonville, Fla." which appeared in the *Monthly Weather Review* for November 1920, and from earlier records of the Weather Bureau. These records are too copious to quote here, but summarizing from them shows the following for the wind movement at Block Island (Montauk):

Yearly Wind Movement at Montauk

1912	159,591 miles	1918	153,774 miles
1913	153,982 "	1919	155,084 "
1914	159,979 "	1920	160,848 "
1915	154,313 "	1921	155,801 "
1916	160,504 "	1922	155,488 "
1917	156,203 "		

It should be remembered in this connection that all the figures from Montauk (Block Island) are based on instruments only forty-six feet above sea level, which is lower than at any of the coastal stations which Mr. Trotter has tabulated. Many of the hills at Montauk are at least twice that height above sea level, and a few three times that height. If the measurements of Stevenson as to the increase of wind with altitude operate

at Montauk as they did at Edinburgh,* then there may well be an increase of from 20% to 50% in wind movement over the greater part of the Downs, and practically all the vegetation has been subjected to wind movement considerably in excess of the figures given in the table.

FIGURE 21. Wind wrenched specimen of white oak (*Quercus alba*) on windward edge of Hither Woods. There are hundreds of such specimens along the seaward edge of the woods, which extends about four miles west-southwest of Fort Pond.

But not only is the strength and distribution of the winds that sweep over Montauk of significance,—their direction is even more so. Summarizing again from the Weather Bureau records, it transpires that except for the occasional 'Northeaster,' the bane of boatman, all these great winds

* Journ. Scot. Meteorl. Soc., new series **5**: 348. 1880; quoted by Schimper, not seen by me.

are west, northwest or southwest. For days on end the white-capped Fort Pond Bay, just off the village, and the thundering of the surf on the seashore are ever present reminders of the force and steadiness of these westerly and southwesterly breezes. In the winter they are apt to be northwesterly.

Quite as much as these marine reminders of the wind is the peculiarly effective response of the vegetation to it. Gnarled and often dead trees (Fig. 21), or trees and shrubs that are normally many feet tall but at Montauk are prostrate or stand up only a few inches, are mute evidence of this ceaseless power of the wind. Other rather striking reminders of this are the individual response of certain herbs, such as prostrate habit, cushion-like clumps, or one-sided growth, and the failure of certain shrubs and all trees to grow on the tops of the Downs, and their practical confinement to the bottoms of kettleholes or other protected places among some of the taller Downs.

Some quantitative expression of the effect of this wind on the vegetation is so far unavailable, except the records of the rate of growth of the scarlet oak on the windward and leeward sides of the Hither Woods, an account of which will be found in the section, "Hither Woods" (Figs. 18 and 19).

But beyond the purely mechanical effect, which is everywhere obvious at Montauk, practically nothing is known of the effect on transpiration and other processes of plant activity of violent gales.*

Once, in 1625, a great storm visited all the northeastern Atlantic coast and reports, mostly apocryphal, tell of severe damage. But on September 23, 1815, a southeast gale of such intensity as to destroy "one half of the forest trees and fruit trees," occurred and there are ample records of it.† The Long Island *Star*, a weekly newspaper, quotes in its issue of October 4, 1815, a letter from a correspondent at Sag Harbor, dated September 24:

* There are many references to the mechanical effects of wind on vegetation, particularly of violent storms or hurricanes, notably: by C. T. Simpson, Plant World **6**: 284–285. 1903; by G. H. Kroll, Bot. Centrl. Beih. **30**[1]: 122–140. 1913; by B. F. Hoyt, Amer. Nat **20**: 1051–1052. 1886; by G. Eisen, Zoe **3**: 1–11. 1892; by H. von Schrenk, Trans. St. Louis. Acad. Sci. **8**: 25–41. 1898; by J. Dufrenoy, Comp. Rend. **69**: 174–175. 1917. There is also an account of the effect of the wind on the trees along the Californian coast in W. L. Jepson's "Silva of California," **2**: 40–44. 1910. Some of these and many others are summarized in Schimper's monumental "Plant Geography" (English version, Oxford, 1903.) More recently, Leonard Hill (Proc. Royal Soc. Ser. B **92**: 28–31. 1921) has written on "The Growth of Seedlings in Wind."

† I am indebted to Mr. Jonathan Gardiner, now in his eightieth year, for first calling my attention to this. Mr. Gardiner, who lives at Easthampton, lived for many years on Gardiner's Island, and has heard several first hand accounts of this storm from people who lived at the time. For the possible effects of salt laden winds destroying vegetation during this storm see also an article by J. B. Beck, Am. Journ. Sci. **1**: 388–397. 1819.

"Yesterday we experienced one of the most tremendous gales ever experienced in this climate. It blew a hurricane. Trees are strewed in every direction about our streets. . . . The lighthouse on Montauk is so injured that no light can be kept in it until the lantern be repaired." The same paper said, on October 11, and on October 18, that the lighthouses on Gull and Little Gull Islands were also out of commission, due to the storm.

Mr. Gardiner reported to the writer that men who had visited Montauk after the storm told him that much timber had been destroyed at the Point Woods, and in fact, all over Montauk Point. But the blowing down of trees such as unquestionably occurred can not have made very much difference in the relative *proportion* of grassland and forest at Montauk. The records already quoted show that from the earliest days there had always been, within historic times at least, large areas of Montauk in grassland. If anything, this storm would tend to increase the area of this. It may well have blown down the tallest trees at the Point Woods, none of which at present is over forty or fifty feet in height,—most of them much lower.

While the wind is the most striking of the climatic features of Montauk, the peninsula is both cooler and drier than any other part of Long Island, In an account of the climate of Long Island as it is related to the vegetation. which will be presented elsewhere, the details of these factors are given. Summarizing from them the Montauk records show the following:

TEMPERATURE

Mean temperature	49.5°	which is 95.1% of the warmest Long Island station.
Yearly effective temperature, = total above 43°	3536°	which is 80.7% of the warmest Long Island station.
Effective temperature before May 31	319°	which is only 49.1% of the warmest Long Island station, and is the explanation of the "late spring" at Montauk, which, in the flowering of certain plants is from ten to fifteen days behind Brooklyn.
Frostless period	218 days	which is longer than for any other Long Island station.

The retarding of spring and the length of the growing season at Montauk are both affected by the temperature of the sea water. This is from 6 to 10° cooler at Montauk than at the western end of Long Island during the period April 15 to June 9, while during the period from November 15 to December 25, it is usually slightly warmer than for the western end of the

Island.* Full details of the temperature of the sea water at the eastern and western ends of Long Island will be published later in another connection.

The Livingston and Shreve direct summation of normal daily mean temperature for the period of the frostless season shows for Montauk (Block Island):

Above 0° F.	Above 32° F.	Above 39° F.†	Above 50° F
12,946	5,970	4,444	2,264

RAINFALL (INCLUDING SNOW)

Annual	41.79 inches,	which is 89% of the wettest Long Island locality.
Amount of rainfall during the period of effective temperature	27.02 inches,	which is 91% of the wettest Long Island locality during this period.

EVAPORATING POWER OF THE AIR.

Of the different types of evaporimeter it was decided to use the Livingston black and white atmometer, largely because the readings from them are more easily comparable to the results of other workers.

All the records were taken with instruments mounted in the usual way, but the bottles in every case (except one to be noted specially) were buried up to the neck. Some of the records were taken before the mercury valve to prevent intake of water had been proposed, but in these records daily readings were made for rather brief periods in September 1919, and May 1920. During 1921 the instruments ran continuously from July 15 to September 24, and in 1922 from July 27 to August 18. Both the 1921 and 1922 readings were made at intervals of several days, with mercury valve instruments.‡ In all cases the accompanying graphs (Figs. 22–25) have been translated to the rate per day (the number of cc. per day) of evaporation.

* There is a brief account of the sea breeze on eastern Long Island and of the effect of this cool sea water on the climate of the Island, both by Ernest S. Clowes of Bridgehampton in *Monthly Weather Review* for July 1917. They show very clearly the effect on the temperature, particularly near the shore, of the sea breeze blowing in from the cool water.

† The nearest figure to the so-called "effective temperature" used above, which is merely the addition of all the degrees of temperature in excess of 43°, which has been used by many other workers as a basis.

‡ The 1921 instruments were supplied with a mercury valve held in place by glass wool. A decided improvement in this was devised by Mr. Frederick A. Musch of New Haven, who kindly made a series of readings for me in the pitch pine region at North Haven, Connecticut. Mr. Musch's ingenious modification of the usual tubing made the mercury valve a most satisfactory device for the Livingston atmometer. See *Science* 57: 26–28. 1923.

During 1919 and 1920 the instruments were set out as follows:

1. On open exposed Downs.
2. At the contact of the Downs with a wooded kettlehole, and about six feet from the wooded fringe of it.

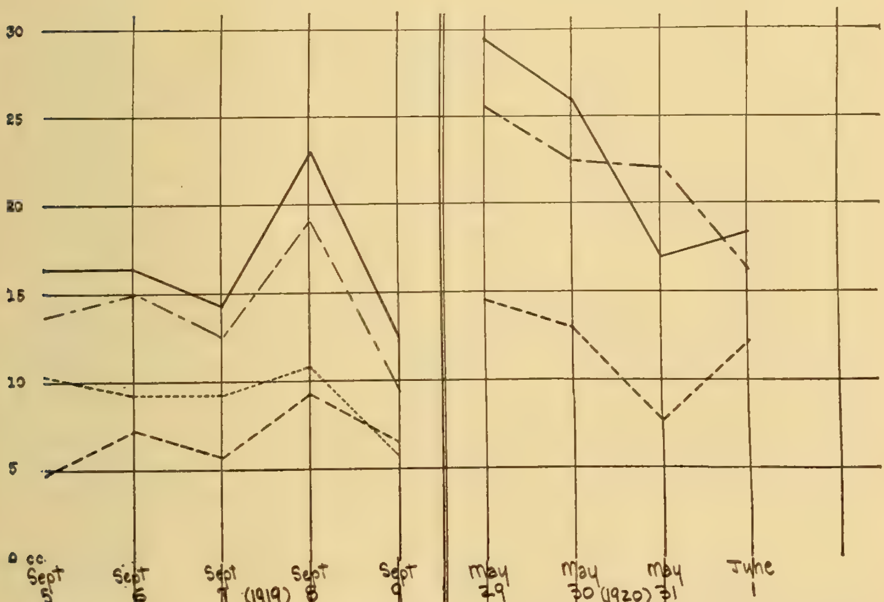


FIGURE 22. Evaporation, White Atmometers. Montauk, Long Island. September 5–9, 1919. May 29–June 1, 1920.

On open downs. ——————

At their contact with wooded kettleholes. — — — — — — —

In Bayberry thicket. - - - - - - - - - - - - -

Under canopy of wooded kettlehole. - - - - - - - - - - - -

Fire had destroyed the bayberry thicket between the 1919 and 1920 readings, so this station is omitted from 1920 graph.

3. In the middle of a bayberry thicket, but as none of the bushes was over one foot high, the instruments were set so that they were not shaded by them.
4. On the forest floor of a wooded kettlehole.

As these 1919 and 1920 graphs show (Fig. 22) there is, as might be expected, a steady increase in the rate of evaporation from the wooded kettlehole to the open Downs, but what they do not tell us is that nowhere on Long Island, as subsequent readings have proved, is there such a violent

contrast between the site producing a forest and a closely adjoining one unable, or only very tardily able to do so. Most other Long Island atmometer readings show, of course, a decided difference in the evaporating power of the air as between [usually artificial] openings and the forest. But at Montauk, as these and the graphs of 1921 show (Fig. 24) that difference is often two to three hundred per cent. There is involved in the kettlehole readings, as in all forest atmometer records, the question of how much they reflect the effect of the forest canopy, and how much the actual difference in site. In other words, whether the forest readings indicate a contributing cause or merely the effect of the forest itself. An interesting sidelight on this is furnished by the 1920 figures, where, because of the lateness of spring at Montauk, the forest canopy had only just begun to really intercept the sunlight. Yet the difference between the Open Downs station and the wooded kettlehole, even during this period, is substantially what it proved to be when the canopy had reached its midsummer density.

The graph for 1921 (Fig. 24) shows an even greater difference between the open Downs and the wooded kettlehole, in some weeks the difference being over five hundred per cent. Taking the figures of the wooded kettlehole as indicative of a reasonably favorable environment for forest growth and reproduction, those of the open Downs suggest an environment at least five times as severe, so far as evaporation is concerned. Such a contrast of environmental conditions, even excluding the occasional fires that sweep over the Downs, would be more than sufficient to explain the mutual exclusiveness of these two dominant sorts of plant covering at Montauk. The shade of the wooded kettlehole prevents the entrance of grassland (of course certain species of *individual* grasses are in all kettleholes, and a few Downs species occasionally do get into them), while the exposure of the Downs to such conditions as these graphs show, effectually prevents nearly all encroachment from the wooded kettlehole out to the open.

One or two features of the atmometer readings of 1921 demand special mention. While atmometers are not supposed to be a measure of wind velocity that is included in the totality of climatic factors which beats upon these instruments. In the case of Montauk the wind velocity is greater than for any other Lond Island station, where atmometer readings have been made. The total evaporation from white atmometers at these different places on the Island, all in the open, and exposed simultaneously was, from July 15 to September 24, 1921:

Montauk	1459.9 cc. = 100%
Crystal Brook, North shore opposite New Haven	1352.2 cc. = 92.6%

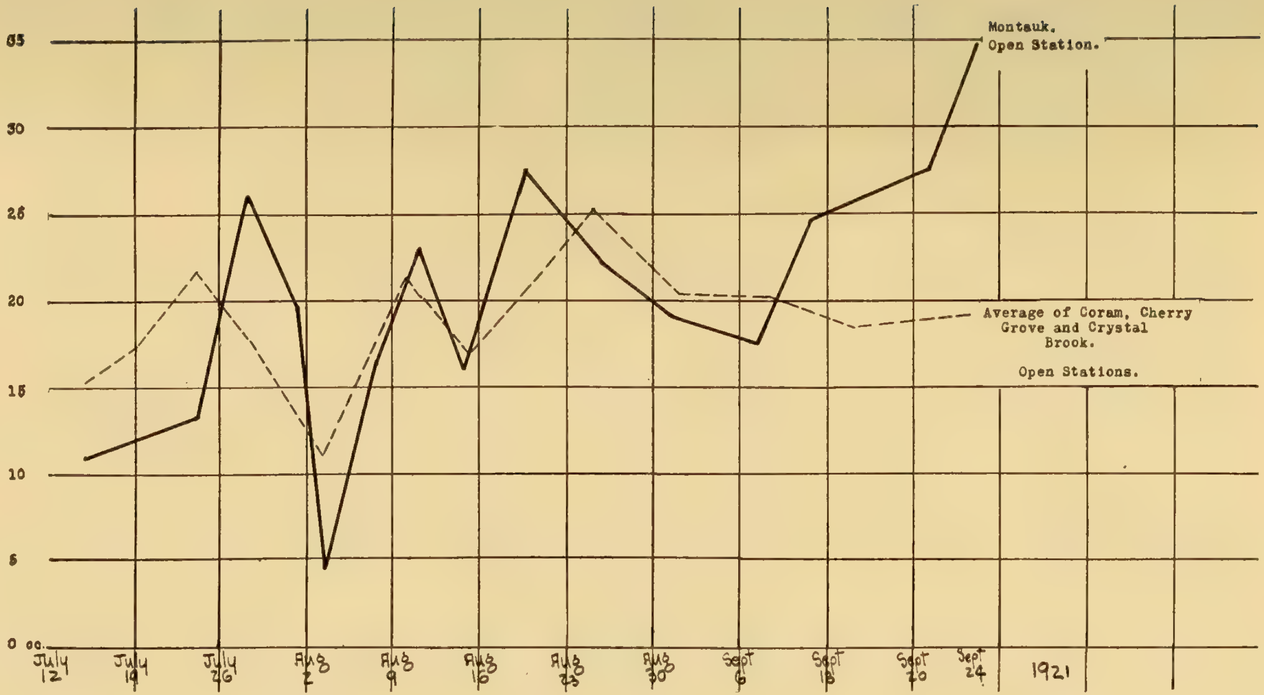


FIGURE 23. White atmometer readings on the Montauk Downs, compared to the open readings from the central portions of Long Island, which have been averaged. 1921. Readings are in cc. of evaporation per day. The atmometer stations in central Long Island which were averaged were at Coram, Cherry Grove and Crystal Brook. See text for details.

Cherry Grove, on Fire Island Beach .... 1311.4 cc. = 89.8%
Coram, in center of Long Island .... 1234.2 cc. = 84.5%

Crystal Brook is in the center of a heavy oak forest and the open station there was selected because it was sheltered from the drying southwest wind of summer. Coram is in the pitch pine region and exposed to this wind, while Cherry Grove is out on the barrier beach, and in full exposure to the winds from the sea. And yet the figures are all within 16% of one another, so that while the conditions of Montauk, judging by the vegetation, are totally different from the other localities, this lack of forest growth, in so far as it is due to wind, is certainly not expressed by the readings of the white atmometers. While the evaporation is higher than for anywhere else on Long Island, it is not so much higher as the vastly different vegetative condition of the Point would suggest it should be.

The accompanying graph (Fig. 23) shows by unbroken and broken lines the details of how the white atmometers in the open at Montauk differed from the other Long Island stations in the open, which have been taken at Coram, Crystal Brook and Cherry Grove and averaged.

Black atmometers were exposed in all the stations, two feet from the white instruments, and appear from the readings to be a more sensitive and perhaps better indicator than the white ones. While neither the white nor black atmometers profess to be an accurate measure of transpiration, the curve of either or of their difference (so called solar radiation) has a very general correspondence to the transpiration of twelve trees as shown by Bates.* To that extent at least the Livingston atmometers, while not a measure of transpiration are a pretty good indicator of its variation over longer or shorter periods, and in average conditions of growth where wind velocity is more normal. In fact, Burns has shown† that "Evaporation-transpiration coefficients based on unit of dry weight . . . show that response of the plants agree more closely with the black atmometer than with the white atmometer." The curves in the paper by Bates, already referred to, also show greater correspondence between the Livingston black atmometer and transpiration, than with any other type of evaporimeter with which he experimented, except the all-metal device which he describes there.

In the light of the statements of Burns and Bates the evaporation from the black instruments at Montauk during the four day period July 25–28

* Bates, C. G. A new evaporimeter for use in forest studies. Monthly Weather Review **47**: 283–294. 1919.

† Burns, G. P. & Hooker, F. P. Studies in tolerance of New England trees II. Relation of shade to evaporation and transpiration in nursery beds. Bull. Vermont Agr. Exp. Sta. **181**: 235–262. 1914.

inclusive (1921) is instructive. As the graph shows, the rate per day of the white instrument for that period was 26.5 cc. During the same time the black instrument touched 49.3 cc., and in fact throughout the season, the black, as would be expected, was consistently higher than the white. But weather conditions during those four days ought not to have produced such black readings, if current theories about that instrument are correct. At Montauk this was the condition as to the main climatic features of these four days, during which no rain fell.

1921	Max. Temp.	Total wind Movement and Direction	Vapor Pressure Inches	Actual sunshine hours	Total Possible sunshine hours
July 25	74	442 mi. SW	.646	5.1	14.6
26	79	389 mi. SW	.732	10.9	14.5
27	77	472 mi. SW	.700	6.0	14.5
28	76	627 mi. SW	.715	11.3	14.5

During two days of that period sunshine did not exceed 76% of the possible, while during the other two it was not over 40% of the possible and yet it is precisely sunshine that is supposed to affect the black instrument most acutely. As the graph shows, this four day period had a higher rate of evaporation than any other part of the season in spite of a partial lack of sunshine during two of the days, and a serious lack of it on the other two. But during those days the total daily movement of wind, and the hourly velocity, were higher than for many days after. For the sake of the record, I append the rate of the black atmometer on the Montauk Downs, the maximum temperature, the vapor pressure, and wind velocity per hour, for the "high spots" on the 1921 graph, together with actual and possible amount of sunshine.

Reading ending	Mean maximum temp. of each period.	Evaporation per day in cc.	Direction and highest velocity of wind during period of atmometer reading	Average vapor pressure inches	Actual sunshine hours*	Possible sunshine hours
July 28	76	49.3	SW 40 mi. an	.698	8.3	14.5
Aug. 12	75	35.8	SW 32 hour	.617	8.7	13.9
Aug. 18	73	40.0	SW 34	.552	7.5	13.7
Sept. 9	76	43.0	SW 22	.556	9.1	12.8
Sept. 24	71	45.0	SW 42	.497	11.2	12.1

* The actual hours have been calculated on the basis of taking the readings for each day of the period ending on the dates in the left hand column, and averaging them. The figure, then, means that during the period of atmometer readings ending with each date, each *day* had on the average the number of hours sunshine given in the next to the last column.

Taking into consideration that the days were considerably shorter toward the end of the readings, it is certainly of significance that at each period of high winds the black instrument shows marked increase in its rate of evaporation. And if, as Bates and Burns have shown, it is a better measure of actual transpiration than the white instrument, it may well be that from the peak readings of the black instruments at Montauk we get the best expression of the most unfavorable environmental conditions on the Downs, and the best picture of, at least the probable effect of wind as it keeps down the establishment on these Downs of almost everything but grassland and bayberry thickets. No one who has visited Montauk when one of these southwest summer winds is blowing, and the temperature is high (for Montauk) can ever fail to be impressed with the unfavorable effect it must be having on transpiration and growth. Coupled with soil conditions, to be described presently, it is undoubtedly the chief factor in keeping things as they are on the Downs.

This high rate of evaporation and probably also of transpiration coinciding with high winds does not conform to the results of Briggs and Shantz.* They found that evaporation and transpiration were much more sensitive to sunshine than to wind, and in fact discount the latter as a factor of importance. That conclusion appears to fly in the face of most practical gardeners' notions of the effect of wind on transplanted seedlings, where, even if the ground be kept moist, wilting is more apt to occur in a high wind than during a period of calm. An examination of the papers cited shows that the highest wind velocity reached in their experiments is 13.5 miles per hour (given by them as 6 meters per second). It may well be that such low velocities are much over-ridden by other factors such as sunshine, as all their graphs show a remarkably close correlation between transpiration, evaporation and sunshine, and almost no correlation between these and changes of wind velocity.

The wind, however, scarcely begins to blow at Montauk until it reaches at least twenty-five miles an hour, and it certainly appears from the records that at velocities of more than that it does have a decided effect. Nor can the "high spots" in the black readings be attributed to specially clear days with a maximum of sunshine. The accompanying tabulations of the conditions and the graphs show that high evaporation from the black instru-

* Jour. Agr. Res. 5: 583–649. 1916, on "Hourly Transpiration Rate on Clear Days as Determined by Cyclic Environmental Factors;" *loc. cit.* 7: 155–212. 1916, on "Daily Transpiration during the normal growth period and its correlation with the weather;" or with *loc. cit.* 9: 277–292. 1917, on "Comparison of the hourly evaporation rate of atmometers and free water surfaces with the transpiration rate of *Medicago sativa.*"

ment* may or may not coincide with the greatest possible sunshine, while it nearly always does with high wind.

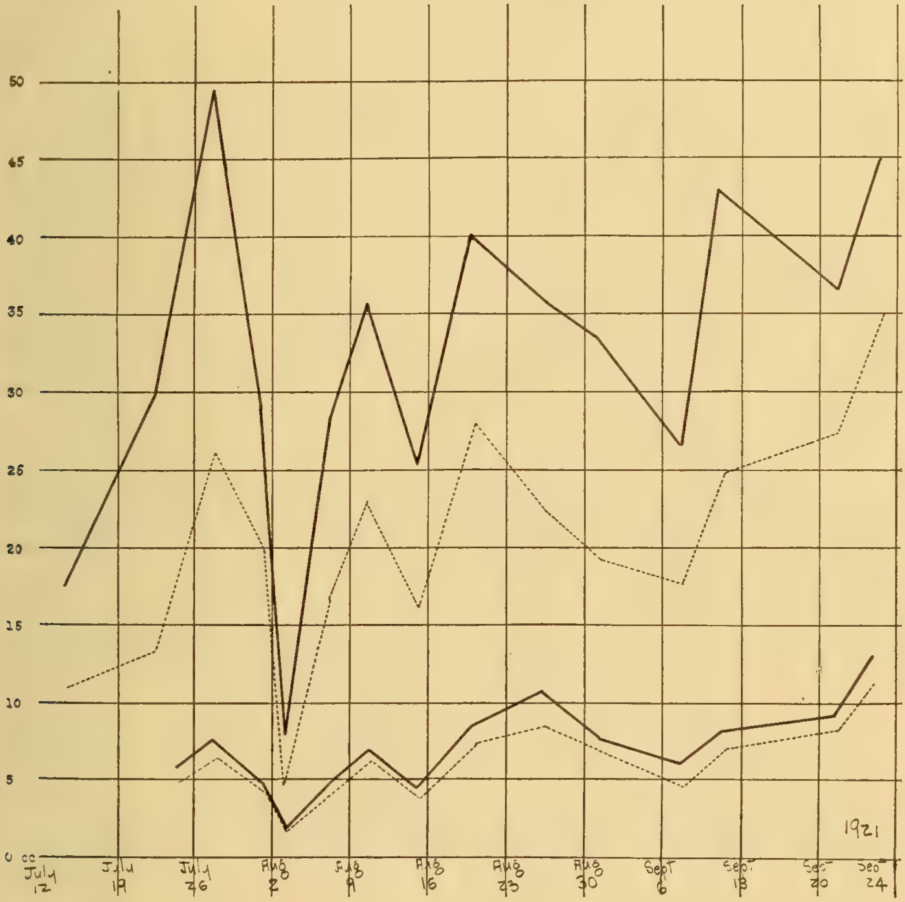


FIGURE 24. Montauk atmometer readings, 1921. Upper series are on the open Downs, lower in the shade of wooded kettlehole. Black lines = black instruments, dotted lines = white instruments. The records are reduced to the cc. of evaporation per day.

* And also from the white instruments. But the blacks show much greater *excess* of evaporation over the whites during high winds than at other times. The basis of the argument in a nut shell is that black instruments reflect transpiration rates better than white ones, and if this is true, as Bates and Burns would have us believe, then high wind movement, as reflected by the meteoric rise of the black instrument, does so affect transpiration as to be one of the chief limiting factors.

An examination of the graph of evaporation (Fig. 24) and of the details of sunshine together with wind velocity, shows, during the period August 19–25, 1921, a good example of the fall of the evaporation rate of the black instrument, in the face of better than the average rate of insolation. The possible amount of sunshine during this period is 13.5 hours per day. The actual sunshine for the period averaged 12.4 hours, which more nearly approaches the possible amount than for any of the peak periods of the black instrument. In the face of these seven days, when sunshine was nearly at its maximum, there is, as the graph shows, a steadily falling rate of evaporation from the black instrument. No rain fell during the period, and the wind averaged but 22 miles per hour, while the mean maximum temperature for the seven days was 70°. Comparison of these conditions with those of the September 24 atmometer readings confirms the point. The maximum temperatures then were one degree cooler, sunlight about one hour less, and yet presumably, under the stimulus of a wind of 42 miles an hour from the southwest, the black instrument climbed to 45.0 cc. of evaporation per day.

The maximum temperature, rainfall, vapor pressure, wind velocity and prevailing wind direction together with the possible and actual amount of sunshine, for the period of these 1921 readings is here recorded, most of the details of which have been kindly placed at my disposal by the Weather Bureau station at Block Island.

Evaporation Black and White Atmometers and Daily Maximum Temperatures, Precipitation, Vapor Pressure, Direction and Velocity of Wind, Hours Possible Sunshine and Hours Actual Sunshine.
Montauk Downs 1921

Date	Max. Temperature	Rainfall	Wind velocity	Wind direction	Hours Possible Sunshine	Hours Actual Sunshine	Vapor Pressure Inches	Evaporation per day in cc. Black	Evaporation per day in cc. White
July									
15	74	.52	38	S W	14.8	0.9	.670		
16	75	.01	22	N E	14.8	6.7	.569		
17	75		19	S	14.8	12.1	.631		
18	74		26	SW	14.8	9.2	.646		
19	75	.24	22	S	14.7	1.2	.700	29.8	13.3
20	79	1.28	25	W	14.7	10.7	.639		
21	68		32	N E	14.7	2.2	.568		
22	71		16	E	14.7	8.9	.530		
23	73		16	E	14.6	11.7	.575		
24	76		24	S W	14.6	14.6	.676		

Date	Max. Temp-era-ture	Rain-fall	Wind veloc-ity	Wind dir-ection	Hours Possible Sunshine	Hours Actual Sunshine	Vapor Pressure Inches	Evaporation per day in cc.	
								Black	White
July									
25	74		25	S W	14.6	5.1	.646		
26	79		24	S W	14.5	10.9	.732	49.3	25.9
27	77		25	S W	14.5	6.0	.700		
28	76		40	S W	14.5	11.3	.715		
29	79	.39	24	S W	14.4	0.7	.699		
30	75		14	S E	14.4	10.8	.676		
31	76	1.06	52	S	14.4	0.0	.702	28.7	19.5
Aug.									
1	68		32	W	14.3	4.0	.461		
2	65	.37	23	S W-W	14.3	0.0	.543	7.8	4.7
3	66	.11	18	E	14.3	0.0	.520		
4	75		13	S E	14.2	10.9	.553		
5	75		17	S W	14.2	14.2	.605	28.4	16.5
6	73		22	S	14.2	14.2	.602		
7	76		24	S	14.1	5.4	.716		
8	75	.29	24	W	14.1	6.9	.627		
9	74		18	W	14.1	14.1	.477	35.8	22.9
10	76		16	S W	14.0	14.0	.638		
11	76		24	S W	14.0	6.8	.692		
12	75	.08	32	S W	13.9	1.7	.661		
13	70		23	S E	13.9	3.3	.610	25.3	16.0
14	75	.22	33	S W	13.8	0.0	.709		
15	72		34	N W	13.8	13.8	.417		
16	74		28	W	13.8	13.0	.494		
17	74	.02	29	S W	13.7	1.7	.596		
18	75	1.96	35	S W	13.7	1.8	.701	40.1	27.6
19	76		21	W	13.6	13.6	.532		
20	75		29	S W	13.6	9.3	.661		
21	70		34	E	13.6	13.6	.461		
22	71		22	NW-NE	13.5	10.0	.455		
23	70		12	E	13.5	13.5	.402	35.6	22.2
24	69		14	E	13.4	13.4	.471		
25	71		28	N E	13.4	13.4	.517		
26	70		32	N E	13.4	13.4	.450		
27	67		20	NE-E	13.3	12.4	.454		
28	69		12	E	13.3	3.1	.513		
29	72		26	S W	13.2	4.8	.625		
30	76		32	S W	13.2	7.6	.676	33.6	19.1
31	75		24	E	13.2	5.8	.631		
Sept.									
1	73		16	E	13.1	13.1	.589		

Date.	Max. Temperature	Rainfall	Wind velocity	Wind direction	Hours Possible Sunshine	Hours Actual Sunshine	Vapor Pressure Inches	Evaporation per day in cc. Black	White
Sept.									
2	77		25	S W	13.0	4.4	.716		
3	83		30	W	13.0	11.8	.654		
4	72		28	N E	13.0	9.9	.530		
5	69		24	E	13.0	11.7	.512	26.4	17.5
6	73	.01	16	S E	12.9	3.7	.676		
7	73	.03	18	E	12.8	7.4	.616		
8	74		12	N	12.8	10.5	.557		
9	76		12	N E	12.8	9.4	.496		
10	74		22	S W	12.7	12.7	.595	43.0	24.6
11	75		21	S W	12.7	9.8	.631		
12	74	.01	11	S	12.6	0.0	.676		
13	76		27	W	12.6	9.8	.531		
14	66		26	N	12.5	6.3	.408		
15	72	.06	26	S W	12.5	10.6	.538		
16	67		19	N E	12.4	10.2	.439		
17	71	.09	30	S-S W	12.4	3.2	.560	36.3	27.4
18	75	.01	36	W	12.4	8.4	.525		
19	66		36	N W	12.3	12.3	.376		
20	65		20	N E	12.2	8.7	.385		
21	68	.19	32	S E	12.2	0.0	.465		
22	74	.15	42	S W	12.2	9.4	.569		
23	74		30	S W	12.1	12.1	.505	44.9	34.8
24	69		13	N	12.1	12.1	.419		

The 1922 readings, which were only made on the open Downs, extend from July 27 to August 18. As the accompanying graph (Fig. 25) shows this happened to be a much less critical period than the previous season, and consequently does not have the significance of the much higher readings of 1921. As a record of the general climatic condition during 1922 I append a detailed weather report by Lieut. Roger W. Autry, the Camp Signal Officer at Camp Welsh. The artillery regiments quartered at Montauk during the summer of 1922 kept a meteorological tent in operation, with observations taken at 8:30 A.M. and 2:00 P.M. It is from these records which are complete except for Saturday afternoons and Sundays, that the following is taken.

EVAPORATION BLACK AND WHITE ATMOMETERS AND DIRECTION AND VELOCITY OF THE WIND, TEMPERATURE, VAPOR PRESSURE, AND SKY.
MONTAUK DOWNS, JULY 21–AUG. 18, 1922.

Date	Direction and Velocity of the Wind	Mean Temperature	Vapor Pressure (inches)	Sky	Evaporation per day in c.c	
					Black	White
July						
20–AM	E–2	71.0	.732	fog		
20–PM	E–10	70.0	.707	cloudy		
21–AM	NW–8	67.0	.638	partly cloudy		
21–PM	S–6	79.8	.684	partly cloudy		
22–AM	SW–8	71.0	.732	clear		
22–PM	——	——	——	——		
23–AM	——	——	——	——	24.1	20.6
23–PM	——	——	——	——		
24–AM	N–8	72.0	.757	clear		
24–PM	NE–6	74.0	.732	cloudy		
25–AM	NE–13	64.2	.575	cloudy		
25–PM	SE–17	68.0	.684	cloudy		
26–AM	SW–8	66.5	.638	partly cloudy		
26–PM	SE–12	69.7	.661	clear		
27–AM	NW–13	66.3	.616	cloudy		
27–PM	SSE–15	73.2	.732	cloudy		
28–AM	SSE–6	68.2	.684	cloudy		
28–PM	SSE–7	70.8	.732	cloudy		
29–AM	NW–14	67.0	.616	partly cloudy		
29–PM	——	——	——	——		
30–AM	——	——	——	——		
30–PM	——	——	——	——		
31–AM	SW–8	69.0	.661	clear		
31–PM	SSE–10	76.1	.757	clear		
August					29.4	18.6
1–AM	N–8	67.0	.707	fog		
1–PM	——	——	——	cloudy		
2–AM	N–5	67.0	.661	rain		
2–PM	NE–7	64.8	.616	cloudy		
3–AM	N–7	65.6	.595	cloudy		
3–PM	SE–5	68.1	.638	cloudy		
4–AM	ENE–7	66.8	.638	cloudy		
4–PM	ESE–8	71.8	.707	partly cloudy		
5–AM	NW–7	69.5	.684	clear		
5–PM	——	——	——	clear		
6–AM	——	——	——	cloudy	24.0	15.7
6–PM	——	——	——	clear		
7–AM	SSW–12	71.5	.745	cloudy		
7–PM	SSW–16	74.9	.757	cloudy		

Date	Direction and Velocity of the Wind	Meaa Tempern-ture	Vapor Pressure (inches)	Sky	Evaporation per day in c.c.	
					Black	White
July						
8-AM	SW-14	69.1	.661	rain		
8-PM	SW-9	71.6	.757	cloudy		
9-AM	NE-18	62.	.517	cloudy		
9-PM	NE-15	66.3	.536	cloudy	24.0	15.7
10-AM	NE-16	63.7	.499	cloudy		
10-PM	NE-14	67.6	.536	cloudy		
11-AM	NE-20	63.1	.432	cloudy		
11-PM	NNE-22	63.0	.482	cloudy		
12-AM	NE-16	63.1	.575	rain		
12-PM	——	——	——	rain		
13-AM	——	——	——	partly cloudy		
13-PM	——	——	——	partly cloudy		
14-AM	W-9	69.8	.684	clear		
14-PM	SW-13	76.0	.707	clear		
15-AM	SSW-5	68.8	.684	fog	27.2	17.7
15-PM	SW-12	71.8	.732	fog		
16-AM	SW-9	70.8	.707	clear		
16-PM	SW-21	74.0	.757	clear		
17-AM	NW-4	75.0	.783	clear		
17-PM	S-4	80.5	.783	partly cloudy		
18-AM	SW-14	70.0	.732	clear		

Lack of wind velocity, such as the table shows, is unprecedented for Montauk, and, if the black instruments are as sensitive to wind as the 1921 readings appear to indicate, their low rate of evaporation during the 1922 period is understandable. So far do the readings of the black or white instruments depart from the normal that the total evaporation from the white atmometer in the open is actually exceeded by a similarly exposed instrument at Coram. There the record from July 27 to August 28 totalled 179.4 cc. more than at Montauk! This excess at Coram is undoubtedly due partly to higher temperature, as the central pine-barren region, at least so far as maximum temperatures are concerned, is always considerably warmer than Montauk. It is partly due also to the lower humidity at Coram. Montauk, surrounded by water, is, in the absence of its usual gales, a decidedly humid region, and during the 1922 readings, as the detailed record shows, the wind never reached a velocity of even twenty-five miles an hour. A glance at the velocities during the 1921 high readings will confirm the statement there hazarded that wind velocity and the rate

of evaporation from the black instrument, if not transpiration itself, are rather closely correlated.

I am glad to make acknowledgments to Dr. Robert L. Dickinson and to Miss Maria B. Fairbanks for making many of the readings of the atmo-

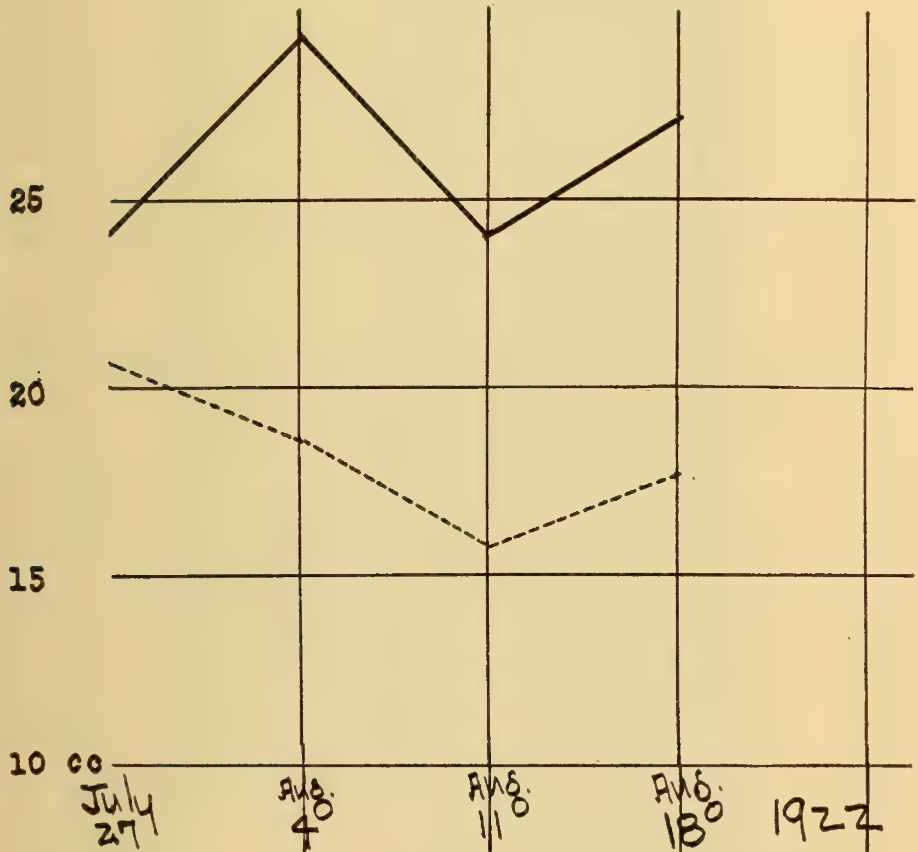


FIGURE 25. Atmometer records on Montauk Downs in 1922. Black line = black instrument, dotted line = white instrument. The records are reduced to the number of cc. of evaporation per day.

meters; to Lieut. R. W. Autry for supplying the meteorological data during the 1922 readings; and to Mr. George W. Eddey, in charge of the U. S. Weather Bureau at Block Island, for many courtesies. All this voluntary assistance has been most helpful in accumulating the data on the climate of Montauk.

FIGURE 26. Roots of *Myrica carolinensis*, near Ditch Plain Coast Guard Station. The roots penetrated 36 inches of fine sand. (Photograph by Barrington Moore.)

Soils.

It is needless to go into the geology of Montauk* more than to say that all of the surface of the peninsula is made up of glacial till of the Ronkonkoma Moraine, and from this, of course, all the soils of Montauk have been derived.

This geologically similar material is by no means matched by a similarity of soils. Considering first the mineral soil, which is soil that remains unmodified by the vegetation,—the subsoil of the gardeners,—it is at once obvious that this differs in different parts of Montauk and under different vegetative types.

Disregarding boulders, small stones and coarse gravel, the available subsoil appears to be, under the typical Downs, a mixture of about 85% coarse yellow sand, and 15% of fine sand with sometimes a slight admixture of silt. It is into such a substratum that the deeper rooted perennials, such as *Baptisia tinctoria*, and all the shrubs, always penetrate (Fig. 26). And of all the Montauk soils these Downs samples are the least favorable for plant growth, being practically wholly lacking in humus (Fig. 27).

In the wooded kettleholes, in the Hither Woods, or in the Point Woods, the subsoil is very different. A glance at figure 28 shows, that on the average, the subsoils under the forest are higher in fine sand or silt than those under the grassland. In the case of the Hither Woods sample the soil is not far in its mechanical composition from the open Downs, and as the earlier description of that region has shown, the forest there is stunted. It is unquestionably the combination of this poor soil and exposure to the winds which holds back the growth of the oaks in the Hither Woods. How much this is retarded on the windward side of them has already been shown.

These different subsoils† appear to have an important influence in controlling the major distribution of the different vegetation types, always, of course, in conjunction with, and subsidiary to, climatic factors. Upon them depend the maintenance of the vegetative *status quo*. But the establishment and reproduction of either old or aggressively competing types must depend upon the upper layer of the soil, in which all alike must first root or germinate their seeds.

* For details of this see Fuller, M. L., The geology of Long Island, Prof. Paper U. S. Geological Survey **82**: 1–231. 1914.

† In this, as in other parts of Long Island, my statements are based on many collections under each type of vegetation, so that the remarks about soil possibilities must be understood to refer to average conditions, rather than individual cases.

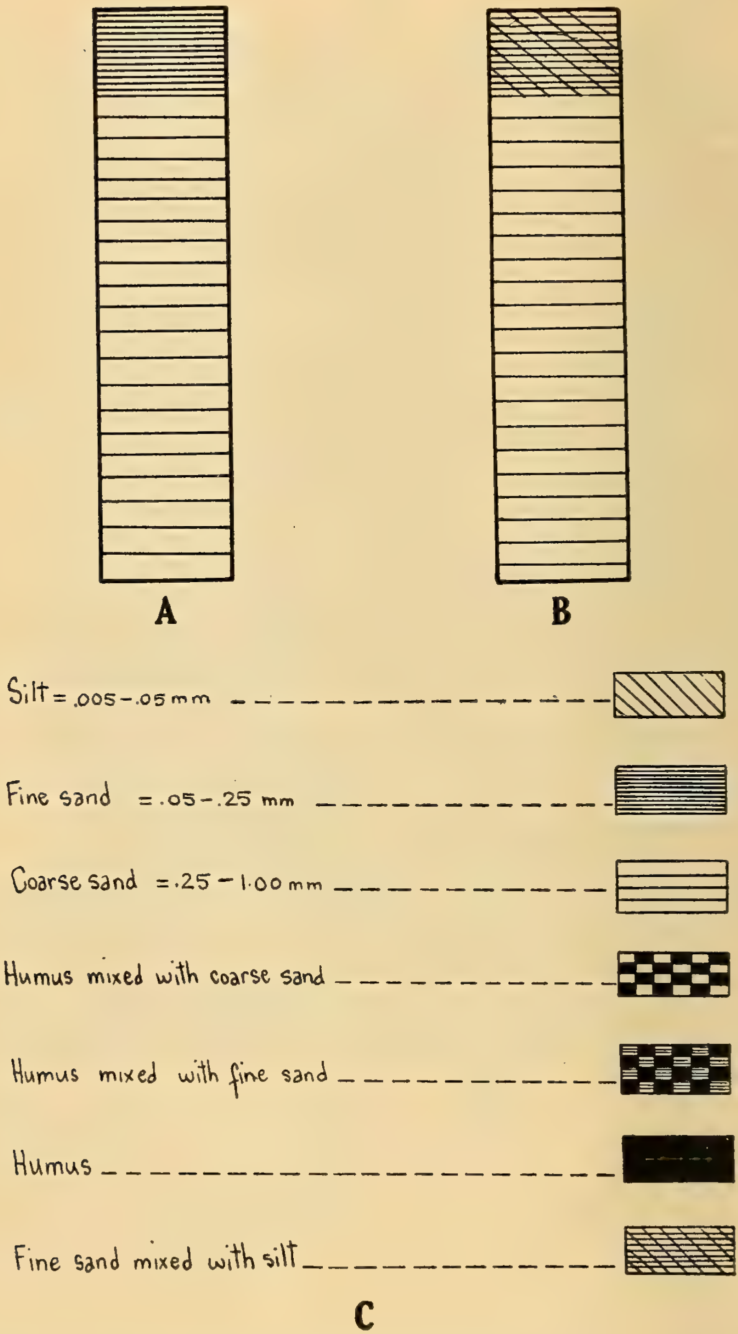


FIGURE 27. (a) Subsoil under open Downs at edge of Hither Woods; 15% fine yellow sand, 85% coarse yellow sand. (b) Subsoil under open Downs between Fort Pond and Great Pond; 16% fine sand and silt, 84% coarse sand. (c) Symbols used to designate size of soil particles in figures 27–30.

This upper layer, humus infested as it always must be, even in the worst sites, is the soil as it has been affected by the decomposition of successive generations of plants that have gone before,—again in the jargon of the gardeners, the topsoil.

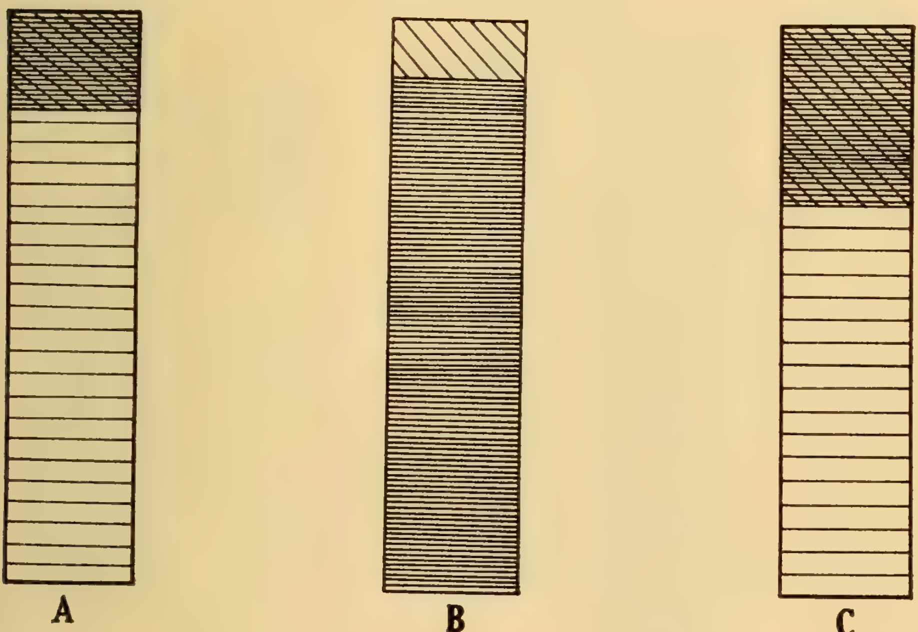


FIGURE 28. (a) Subsoil under the Hither Woods; 17% fine sand and silt, 83% coarse sand. (b) Subsoil under wooded kettlehole; 90% of fine sand, 10% silt. (c) Subsoil under Point Woods; 68% coarse light sand, 32% fine light yellow sand and silt.

On the Downs this surface soil, often of varying thickness depending on the slope, is usually made up of much the same basic material as the mineral soil under it, but as Fig. 29 shows, with a pretty large proportion of humus in it. In the case of the surface soil under the woods, the same general proposition holds true, with the exception of the surface soil under the woods at Montauk Point. See figure 30.

These purely mechanical features of the soil are perhaps best measured, so far as their effects upon the vegetation are concerned, by the Hilgard*

* See Hilgard, E. W. Soils, Chapter IX, pp. 188–266, on "The Water of Soils," 1919. Also "The Wilting Coefficient for Different Plants and its Indirect Determination," by L. J. Briggs and H. L. Shantz, Bull. Bur. Plant Industry **230**: 1–83. 1912.

method of determining the moisture holding capacity of them, and the Briggs and Shantz method of determining their wilting coefficient.

The moisture holding capacity of the subsoils of Montauk shows that, under the open Downs, they average 33.4%, while under the forest, averaging Hither Woods, Point Woods, the island in Great Pond, North Neck Woods, and wooded kettleholes, the figure is 39.9%. The interesting thing

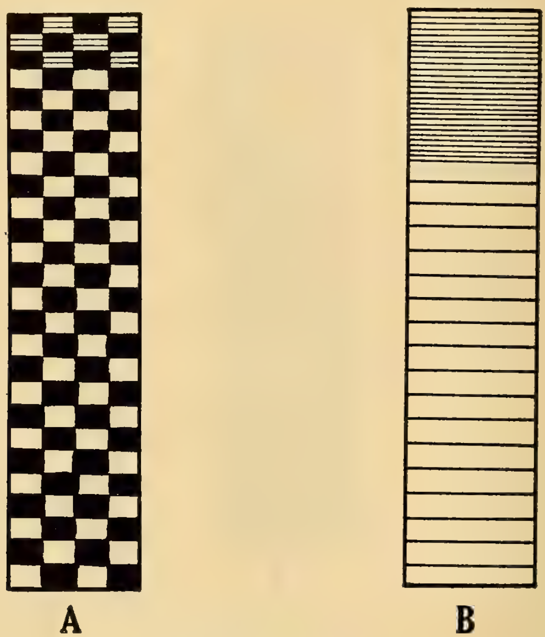


FIGURE 29. (a) Surface soil under open Downs near Hither Woods; 91% coarse sand and humus, 9% fine sand and humus. (b) Surface soil under open Downs between Fort Pond and Great Pond; 74% coarse sand, 26% fine sand, both darkened by humus, but not as much as in the sample from near the Hither Woods (a).

about these figures is that both of them are well above those for other regions of Long Island which sustain similar types of vegetation.

Taking the only other grasslands on Long Island we find the moisture holding capacity of their subsoils, as compared to Montauk, is as follows:

Hempstead Plains 28.9% Shinnecock Hills 26.5%

Montauk Downs 33.4%

The Montauk figure is not only considerably higher than any other grassland on the Island, it is even higher than the average of seventeen pitch pine subsoils over the rest of Long Island, the moisture holding capac-

ity of which is 31.6%. Considering the pitch pine type of vegetation as indicative of only slightly better conditions than the grasslands we are confronted with moisture holding capacity figures that are better than the average pitch pine soils, and yet a failure to produce this type of vegetation at Montauk.

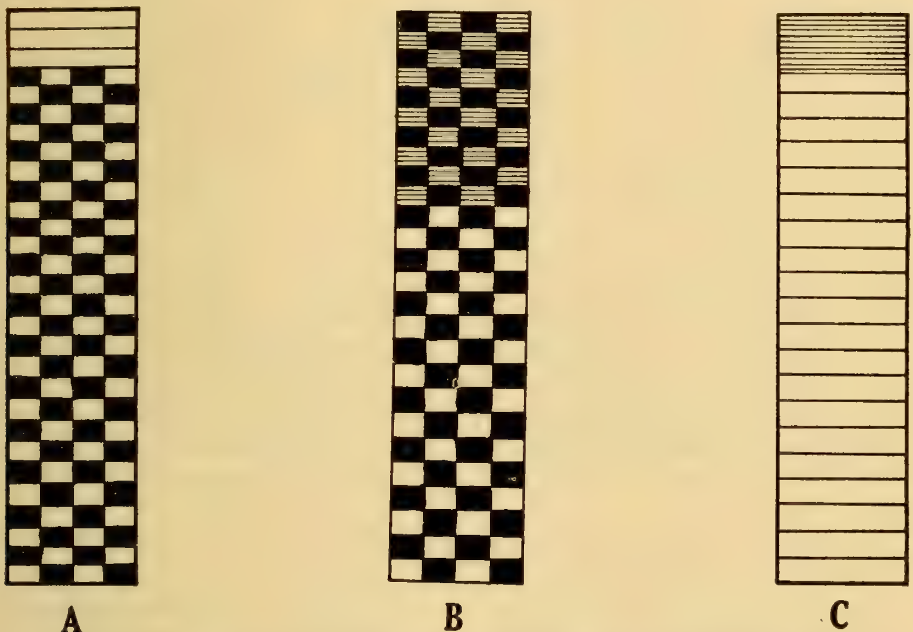


FIGURE 30. (a) Surface soil under Hither Woods; 90% humus and coarse sand, 10% coarse sand. (b) Surface soil under wooded kettlehole; 66% coarse sand and humus, 34% fine sand and humus. (c) Surface soil under Point Woods; 90% coarse sand, 10% fine sand, both only slightly darkened by humus.

In the case of the woodlands there is also a difference, as under eighteen different stations on Long Island, all supporting an oak forest, the moisture holding capacity of the subsoils averages 37.4%, while the figure for Montauk forest growth is 39.9%.

Both on the Downs, and in what woods occur at Montauk, there is thus a soil condition better than in other parts of Long Island, and, as we have seen, the failure to produce vegetation that might be expected to result from such conditions appears to be due to factors of climate already discussed.

Considering only the surface soils we have the following condition:

Grasslands	Moisture Holding Capacity
Montauk Downs	43.0%
Hempstead Plains	44.0
Shinnecock Hills	33.6
Forest	
Montauk	70.5%
17 Pitch Pine stations on L. I.	83.9
18 Oak stations on L. I.	97.2

The wilting coefficient of Montauk soils, is as follows:

Subsoils	Wilting Coefficient
Open Downs	4.7%
Forest	5.6
Surface soils	
Open Downs	6.1%
Forest	15.1

Other grasslands on Long Island average for the wilting coefficient of their surface soils 7.8%, which is close enough to the Montauk Downs to be of little significance. As might be expected, the *surface* soil, on grasslands, once that type of vegetation has become established, ought not to vary much from one place to another, for in every case we are recording not the capacity of the soil itself, but rather how that capacity has been affected by the vegetation which has captured it. That is why the wilting coefficient of the surface soils of all these Long Island grasslands is so nearly uniform.

While the fertility of Montauk soil is not known with any accuracy, one criterion of it is the vegetable garden near the Inn. This is about two acres, protected from most of the wind, and several years observation of it appears to indicate average fertility. Certainly the soil there is no worse than in hundreds of other gardens on eastern Long Island.

In attempting to see if the hydrogen-ion concentration of the soil has any effect on the vegetation many scores of tests according to the method of Wherry* have been made at Montauk.

Except for highly specialized habitats, such as cranberry bogs and salt marshes, the general uniformity of the specific acidity of these soils is noteworthy. From experience in making hundreds of these tests on other Long Island soils, as well as at Montauk, it may be safely stated that soils that range from a specific acidity of 3+ to 30+, or in most cases even to 100, are without significance, as to influencing the distribution of the major features of the vegetation. So far as individual *species*

* Wherry, E. T. Ecology **1**: 42–47, and 160–174. 1920. Rhodora **22**: 33–41. 1920. Amer. Fern. Jour. **10**: 15–22. 1920. Proc. Phil. Acad. Nat. Sci. **72**: 113–119. 1920. Smithson. Rep. **1920**: 247–268. 1922.

are concerned, there appear to be limits, but they are usually rather wide limits within which they prefer to grow. But even here the number of exceptions makes it hazardous to say that they will only grow in what appears to be their preferred habitat. And when it comes to whole vegetation types, the case is hopeless, as within each may be found an infinite variety of specific acidities, and nowhere that the writer has studied, any uniformity of it as to amount. Practically the only thing that may safely be said of the Montauk soils (excluding bogs and salt marshes) is that they vary in specific acidity from 3+ to 30+, and that this is without distributional significance, so far as the occurrence or extent of major vegetative covering is concerned Another factor which leads to accepting specific acidity with considerable caution as an active determinant in the distribution of vegetative types, is that it is a measure of what the decomposition of the plants has done to the soil, rather than a measure of the specific acidity of the soil *per se*. The tests for subsoils demonstrate this, as all over Long Island these vary only (with minor exceptions) from 3+ to 10. The surface soils, due to decomposition of the different types of vegetation supported by them, vary considerably, but as at Montauk, only within limits of little significance. In regions where there is a deeper accumulation of humus the variation is of course greater and of much more significance, as for instance, in the spruce forests in the north.

Summary.

Montauk, which within historic times at least, has always been predominantly grassland, appears to be incapable of producing a forest, except under conditions of protection from the wind, and where there is available water. This, in spite of the fact that temperature, rainfall, humidity, evaporation and physical characteristics of the soil are as good as, or better than, those in the vicinity where forest growth is normal. The region is well within the general forest area of the northeastern states, and yet appears to be incapable of producing a forest, as that term is ordinarily understood. Of all the environmental factors, the wind is unquestionably the most important, and it may, upon subsequent experimentation, prove to be *the* factor.*

* It is a local tradition that trees will not grow on the exposed Downs. To test this twelve oaks (three each of four different species) were set out on the property of Guy DuVal, Esq., with different exposures to the wind. It is too early to report upon their condition, and as they are protected from fire and cattle, but not cultivated or watered, their response to their environment will be of interest. I am grateful to Mr. DuVal for this and for many other courtesies during numerous visits to Montauk.

While there is not much question that there have always been Downs and wooded kettleholes, and that the Hither Woods have always been about as they now are, there is at least some evidence that Montauk was once more thoroughly timbered than it has been since the first whites came there in 1640.

In 1849, J. A. Ayres wrote a book called "The Legends of Montauk," in which he says: "The limits of Montauk were once, perhaps, somewhat greater than they are at present. On the north side near the Great Pond are the *remains of a pine forest* which stood on ground now covered by the sea. The roots remain buried in the sand and are visible only on the receding of the tide." The writer has never seen these during the last ten years, and such evidence taken by itself would not be conclusive. But Elias Lewis, in his "Ups and Downs of the Long Island Coast"* says: "At Montauk Point, north of the lighthouse, is a low swampy place over which the tides sometimes rise. We are informed by Mr. J. F. Gould, who was for many years keeper of the lighthouse, that stumps are laid bare in front of this swamp, at the sea-margin, when the tide is extremely low." As hundreds of similar cases are known on Long Island, where what is now water or salt meadow was once forest, the Montauk records are, no doubt, simply local corroboration of a pretty common phenomenon. They all imply that the forest, and of course the island itself, was once more extensive than it now is.

That conception involves the proposition that the old coastal plain, marked roughly by the present 100 fathom contour, which is now far out to sea, supported a forest growth, which, through the submergence of this plain, was destroyed. The unquestioned occurrence of stumps of this now buried forest certainly supports this view.† At Block Island, Dr. Hollick postulates the destruction of the forest that remained after the submergence of this old coastal plain as due to man, but that, as the historical record indicates, could scarcely have happened at Montauk. But whether removed by the agency of man or the elements, the re-establishment of forest over Montauk or Block Island, without the protection, which the old coastal plain must have afforded, is practically impossible, except in locally protected places. Nor does it need much protection from these severe conditions to produce a forest, for at Gardiner's Island, only ten miles away, there is the finest deciduous forest growth on Long Island, if not in the whole of New York State.

* Pop Sci. Mo. **10**: 434–446. February 1877.

† See Hollick, A. Trans. N. Y. Acad. Sci. **16**: 9–18. 1898; Ann. N. Y. Acad. Sci. **11**: 55–72. 1898; Trans. N. Y. Acad. Sci. **12**: 189–202. 1893; Bull. N. Y. Bot. Gard. **2**: 392. 1902; and numerous papers by M. L. Fernald, who has adopted and greatly amplified the view of the effect of this old coastal plain on the distribution of species along the Atlantic coast.

PART II. FLORA OF MONTAUK.

It should be said at once that there has been no serious attempt to make collections of all the species that grow at Montauk, nor are introduced plants included here, unless they have entered into some of the vegetation types treated in Part I. But during many visits there, and in the course of a good deal of walking over the area, herbarium specimens were collected as they were necessary for the identification of species in certain associations of plants, or as their collection did not interfere with the study of the vegetation. It is from the accumulation of these notes and specimens that the following list has been made. While there can be no pretense that it is complete, it does at least show what species make up the great bulk of the flora of Montauk.

It is a pleasure to make acknowledgments to Mr. Kenneth K. Mackenzie for identification of the sedges; to Professor A. S. Hitchcock and Mrs. Agnes Chase for the grasses; to Dr. R. C. Benedict for the ferns and their allies; to Mr. W. W. Eggleston for *Crataegus;* to Mr. Paul C. Standley for *Vaccinium;* to Prof. E. S. Burgess for *Aster;* and to Dr. F. W. Pennell for certain Scrophulariaceae and for *Kneiffia.*

The names and specific identities, with a few trifling exceptions, are those in the writer's "Flora of the Vicinity of New York," which, in essentials, was based upon the "Illustrated Flora" of Dr. N. L. Britton and the late Addison Brown.

Practically all, except the records of the very commonest species, are supported by specimens. These are mostly in the herbarium of the Brooklyn Botanic Garden, while a few are in the collections at the New York Botanical Garden. Several score are based on specimens collected by Mr. William C. Ferguson of Hempstead, most of which he has presented to our collections. All other records are based upon field observations of the writer, or upon those of Mr. Ferguson. It is a genuine pleasure to acknowledge this assistance from Mr. Ferguson, who has also made many notes on the rarity or commoness of certain grasses, sedges, and some other plants, which have been used in tabulations of the Raunkiaer "Growth-Forms," as these have been developed under the highly specialized conditions at Montauk.*

* The specimens collected at Montauk as well as many others from different parts of Long Island are all being studied with a view of getting out a "Flora of Long Island." The local Long Island collections of the Brooklyn Botanic Garden now number twenty

Explanatory Note.

The letters contained in the notes about the distribution of the different species mean the following:

V R = Very rare
R R = Rather rare
R = Rare
V C = Very common
R C = Rather common
C = Common

Usually where localities are cited it means that there is a specimen from that place, but, especially in the case of common plants, they are more widely distributed than the citation to the definite localities would appear to indicate. It is for this reason that the above plan has been adopted.

For place names see the map at the beginning of this book. As there defined "Montauk" means from the western end of Fort Pond to Great Pond; "Montauk Point" from the eastern edge of Great Pond to the Light house; and the "Hither Woods," as from the very earliest days, is applied to the forested tract west of Fort Pond.

Ferns and Fern Allies.

Ophioglossaceae

Botrychium obliquum. Woods at Oyster Pond; V R.

Osmundaceae

Osmunda Claytoniana. Wooded kettleholes; R C.
Osmunda cinnamomea. Kettleholes; thickets at Montauk Point; V C.
Osmunda regalis. Kettleholes. R C.

Polypodiaceae

Onoclea sensibilis. Kettleholes; Island in Great Pond; Montauk Point; R C
Dennstaedtia punctilobula. Kettleholes; Montauk Point; R C.
Dryopteris intermedia. Wooded kettleholes; R R.
Dryopteris noveboracensis. Wooded kettleholes; R C.
Dryopteris spinulosa. Kettleholes; Oyster Pond; R R.
Dryopteris Thelypteris. Kettleholes; V C.
Anchistea virginica. Kettleholes; R C.

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thousand specimens, not counting collections of the writer (about three thousand), the herbarium of Miss F. A. Mulford of Hempstead (about three thousand), several hundred specimens presented by Mr. Ferguson, an equal number of Lieut. Alexander Gershoy, and the herbarium of Miss A. E. Hamilton of Baldwin (1245 specimens).

Lorinseria areolata. Kettleholes; R.
Athyrium Filix-foemina. Wooded kettleholes; woods at Montauk Point; R R.
Athyrium thelypteroides. Open kettleholes; R C.
Pteridium aquilinum. Hither Woods; wooded kettleholes; Island in Great Pond; Point Woods; C.

EQUISETACEAE

Equisetum arvense. Waste places; C.

LYCOPODIACEAE

Lycopodium adpressum. Kettleholes; V R.
Lycopodium inundatum. Bog near Hither Woods; Montauk Point; V R.

Flowering Plants

PINACEAE

Pinus rigida. Dunes near Gin Beach; V R. Practically unknown except for a single wind-wrenched, stunted tree growing in pure sand, among *Ammophila*, *Lechea*, *Hudsonia*, and other dune species; but not very near the beach.
Juniperus virginiana. Edge of Hither Woods; Gin Beach; V R.

MONOCOTYLEDONES

TYPHACEAE

Typha angustifolia. Edge of Fort Pond; Island in Great Pond; R R.

SPARGANIACEAE

Sparganium americanum. Open Kettleholes; C.
Sparganium eurycarpum. Montauk Point; R R.
Sparganium lucidum. Oyster Pond; south end of Great Pond; R R.

ZANNICHELLIACEAE

Ruppia maritima. Oyster Pond; R C, but not found in many places.
Potamogeton dimorphus. Montauk Point; R R.
Potamogeton diversifolius. Ponds; R C.
Potamogeton Oakesianus. Kettleholes Montauk Point; Oyster Pond; R.
Potamogeton pectinatus. Ponds; R R.
Potamogeton perfoliatus. Reed Pond; Fort Pond; R C.
Potamogeton pulcher. Pond near Ditch Plain; R R.

ALISMACEAE

Alisma subcordatum. Open kettleholes; V C.
Sagittaria latifolia. Open kettleholes; V C.

Elodeaceae

Vallisneria spiralis. Stream in Point Woods; Reed Pond; R R, but abundant where found.

Poaceae

Andropogon furcatus. Wide spread on the downs; C.
Schizachyrium scoparium. Dominant grass on the downs; V C.
Sorghastrum nutans. Downs and edge of Fort Pond; V C.
Paspalum psammophilum. Sand dunes; R R.
Paspalum setaceum. Downs near Hither Woods; R R.
Echinochloa Crus-galli. Open kettleholes; probably a relic of grazing. Introduced. R C.
Echinochloa Walteri. Oyster Pond; R R.
Panicum clandestinum. Open but high kettleholes near Culloden Point; R R.
Panicum columbianum. Downs; C.
Panicum Commonsianum. Downs; C.
Panicum depauperatum. Downs; V R.
Panicum dichotomiflorum. Oyster Pond; V R.
Panicum huachucae. Open downs; Hither Woods; R R.
Panicum implicatum. Thicket northwest of Inn; R.
Panicum meridionale. Hither Woods; open downs north of Inn; R R.
Panicum microcarpon. Oyster Pond, and edges of wooded kettleholes; R C.
Panicum Scribnerianum. Open downs; C.
Panicum sphaerocarpon. Downs; R C.
Panicum tennesseense. Wooded kettleholes; R R.
Panicum tsugetorum. Hither Woods; R C.
Panicum virgatum. Near Fort Pond and open kettleholes; R C.
Cenchrus carolinianus. Montauk Point; sand dunes; R R.
Anthoxanthum odoratum. Sparingly introduced; R R.
Aristida dichotoma. Culloden Point; R R.
Aristida purpurascens. Hither Woods; Downs; R.
Aristida tuberculosa. Beach; V R.
Cinna arundinacea. Oyster Pond; Reed Pond; C.
Agrostis alba. Freely introduced on the downs; Hither Woods; V C.
Agrostis maritima. Salt marshes; R R.
Agrostis perennans. Open stage of low kettlehole; C.
Ammophila arenaria. Dunes near Gin Beach; V C, but only at a few places.
Deschampsia flexuosa. Downs, and in Hither Woods; V C.

Danthonia spicata. Hither Woods; R.
Spartina Michauxiana. East of Inn; R.
Spartina patens. Fort Pond; V C, but only at a few places.
Spartina stricta. Fort Pond; R C.
Phragmites Phragmites. Island in Great Pond; V R.
Leptochloa fascicularis. Island in Great Pond; V R.
Eragrostis pectinacea. Downs; R R.
Poa pratensis. Downs; R R perhaps the result of grazing.
Poa triflora. V R.
Panicularia acutiflora. Kettleholes east of Inn; Montauk Point; R R.
Panicularia nervata. Wooded kettleholes north of Inn; R C.
Panicularia obtusa. Montauk Point; V R.
Panicularia pallida. Kettleholes; R R.
Elymus striatus. Oyster Pond; V R.

Cyperaceae

Cyperus dentatus. Fort Pond and open kettleholes; Oyster Pond; C.
Cyperus diandrus. East side of Great Pond; R C.
Cyperus filicinus. East side of Great Pond; R C.
Cyperus filiculmis. Open downs; C.
Cyperus rivularis. Oyster Pond; V R.
Cyperus strigosus. Oyster Pond; V R.
Eleocharis acicularis. Fort Pond; V R.
Eleocharis Engelmanni. V R.
Eleocharis obtusa. Often the pioneer herb in low open kettleholes with seasonal ponds in them; V C.
Eleocharis palustris. Oyster Pond; Fort Pond; R C.
Eleocharis tenuis. Open kettleholes; R C.
Eleocharis tuberculosa. Oyster Pond; R R.
Eriophorum virginicum. Bogs at Montauk Point; R R.
Scirpus americanus. Open kettleholes; Fort Pond; V C.
Scirpus cyperinus. Open and partly wooded kettleholes; V C.
Scirpus debilis. Oyster Pond; open kettleholes; R C.
Scirpus robustus. Gin Beach; R.
Scirpus validus. Swamp; R R.
Dulichium arundinaceum. Most moist places; V C.
Rynchospora alba. Oyster Pond; Great Pond; R C.
Rynchospora glomerata. Great Pond; Oyster Pond; Fort Pond; R C.
Mariscus mariscoides. Island in Great Pond; north of Inn; R C.
Carex alata. Open kettleholes; north of Inn; R R.

Carex albolutescens. Oyster Pond; Open kettleholes; R C.
Carex annectens. Kettlehole west of Inn; R R.
Carex blanda. Woods near Reed pond; R.
Carex canescens. East of Inn; R C.
Carex cephalantha. Near Culloden Point, on shore; Kettleholes east of Inn; R C.
Carex comosa. Wooded kettleholes northeast of Inn; R R.
Carex crinita. Near Oyster Pond; R.
Carex flexuosa. East of Great Pond; R.
Carex folliculata. Montauk Point; R C.
Carex hormathodes. Pool, Montauk Point; Oyster Pond. C.
Carex Howei. Open kettleholes near Ditch Plain; R.
Carex laevivaginata. R.
Carex lanuginosa. Near Culloden Point, on shore; north of Reed Pond; R.
Carex leptalea. East of Great Pond. R.
Carex lupulina. Kettleholes east of Inn; R R.
Carex lurida. Fort Pond; Reed Pond; C.
Carex Muhlenbergii. Downs; C.
Carex pennsylvanica. Hither Woods; R R.
Carex rosaeoides. Wooded kettleholes north of Inn; R.
Carex scoparia. Bog near Hither Woods; Open kettleholes; bog at Montauk Point; mostly as to the form *C. scoparia tessellata* Fernald; V C.
Carex silicea. Oyster Pond; Sea beaches; C.
Carex stipata. Near Oyster Pond; R R.
Carex Swanii. Near Oyster Pond; R R.
Carex vesicaria. Culloden Point, on shore; V R.
Carex vulpinoidea. Oyster Pond; V R.

Araceae

Arisaema triphyllum. Rich woods, Montauk Point; wooded kettleholes; R R.
Spathyema foetida. Low places in Point Woods; R R.
Acorus Calamus. Open kettleholes; Montauk Point; R R.

Xyridaceae

Xyris flexuosa. Low places; Montauk Point; R C.

Eriocaulaceae

Eriocaulon septangulare. Edge of Fort Pond; R R.

Pontederiaceae

Pontederia cordata. Pool near Ditch Plain; R R.

Juncaceae

Juncus acuminatus. Oyster Pond; Open kettleholes; R C.
Juncus articulatus. Brackish marsh, Fort Pond; V R.
Juncus bufonius. Low places; V C.
Juncus canadensis. Most low places; V C.
Juncus dichotomus. Fort Pond; open kettleholes; V C.
Juncus effusus. Scattered in low kettleholes; R C.
Juncus Greenei. Downs; V C. Its tufts rather conspicuous on the open downs.
Juncus marginatus. Oyster Pond; kettleholes on Montauk Point; R R.
Juncoides campestre. Downs; R C.

Melanthaceae

Uvularia sessilifolia. Wooded kettleholes; Point Woods; C.

Liliaceae

Lilium canadense. Oyster Pond; also near Fort Pond; R R.
Lilium philadelphicum. Oyster Pond; R R.
Lilium superbum. Along edges of ponds, marshes, Montauk Point; V R.

Convallariaceae

Vagnera racemosa. Island in Fort Pond; Montauk Point; R R.
Unifolium canadense. Point Woods; C.
Medeola virginiana. Point Woods; R C.

Smilaceae

Smilax glauca. In thickets and kettleholes; V C.
Smilax herbacea. Oyster Pond; R R.
Smilax rotundifolia. In thickets and kettleholes; C.

Amaryllidaceae

Hypoxis hirsuta. Point Woods; wooded kettleholes; R R.

Iridaceae

Iris prismatica. Meadows about Fort Pond; C.
Iris versicolor. Marsh near "Third House"; low kettleholes; R C.
Sisyrinchium arenicola. Downs; C.
Sisyrinchium atlanticum. Open kettleholes; C.

Orchidaceae

Perularia flava. Old collection, not recently seen; V R.
Blephariglottis ciliaris. Fort Pond; R.
Blephariglottis lacera. Open downs; R R.

Blephariglottis psycodes. Reed Pond; V R.

Pogonia ophioglossoides. Most moist places; V C.

Arethusa bulbosa. Bogs at Montauk Point; V C, perhaps more so than at any other Long Island locality, except in the region north of Manorville.

Limodorum tuberosum. Bogs; V C.

Ibidium cernuum. Fort Pond; Montauk Point; R R.

Ibidium gracile. Downs; Montauk Point; R R.

DICOTYLEDONES

Salicaceae

Populus grandidentata. Thickets and in wooded kettleholes; R C.

Populus tremuloides. Near Fort Pond; R R.

Salix cordata. Edge of Great Pond; R.

Salix discolor. Kettleholes, and sometimes on Downs; north of Inn; R R.

Salix nigra. Fort Pond; R.

Salix sericea. Fort Pond; R.

Salix tristis. Downs Montauk Point; R R. Nothing like so plentiful as on other parts of Long Island, such as Hempstead Plains, for instance.

Myricaceae

Myrica carolinensis. Common on the Downs; V C.

Myrica Gale. Edge of Great Pond; R R.

Comptonia peregrina. Hither Woods; C.

Juglandaceae

Hicoria alba. Wooded kettleholes; R R. Caryo

Hicoria glabra. Hither Woods; Point Woods; R R.

Betulaceae

Carpinus caroliniana. Near Reed Pond; V R.

Corylus americana. Wooded kettleholes near Inn; Island in Great Pond; R R.

Betula populifolia. In some wooded kettleholes; often a pioneer in young thickets; C.

Alnus incana. Swamps in Point Woods; R R.

Alnus rugosa. Pool in Point Woods; R C.

Fagaceae

Fagus grandifolia. In wooded kettleholes; Hither Woods; North Neck Woods; R R.

Castanea dentata. Hither Woods, mostly dead; R C. Once a considerable element in the forest areas of the region.
Quercus alba. Hither woods; wooded kettleholes, and many other places; V C.
Quercus coccinea. In all wooded places on Montauk; V C.
Quercus rubra. Hither Woods; Island in Great Pond; R R.
Quercus velutina. Most wooded places on Montauk; C.

CANNABINACEAE

Humulus Lupulus. Island in Great Pond; V R.

URTICACEAE

Boehmeria cylindrica. Wooded kettleholes; R R.
Boehmeria Drummondiana. Near Fort Pond; V R.

POLYGONACEAE

Rumex Acetosella. Downs; V C. Introduced.
Rumex Britannica. Between Reed and Oyster Ponds; R.
Rumex crispus. Downs and along roadsides; C. Introduced.
Rumex persicarioides. Kettleholes; Great Pond; Oyster Pond; V R.
Rumex verticillatus. Oyster Pond; Reed Pond; R R.
Polygonum buxiforme. Fort Pond; Downs; Reed Pond; C.
Polygonum maritimum. Beaches; V R.
Polygonum neglectum. Beach near Oyster Pond; R.
Tovara virginiana. Oyster Pond; V R.
Persicaria hydropiperoides. Low open kettleholes; V C.
Persicaria pennsylvanica. Low open kettleholes; V C.
Persicaria punctata. Downs and open kettleholes; C.
Persicaria setacea. V R.
Tracaulon arifolium. Edge of Pool, Montauk Point; R C.
Tracaulon sagittatum. Kettleholes; R C.
Tiniaria scandens. Thickets; C.
Polygonella articulata. Downs; R C.

CHENOPODIACEAE

Chenopodium rubrum. Waste places and roadsides; V R.
Atriplex arenaria. Fort Pond; R.
Atriplex hastata. Beaches; R C.

AIZOACEAE

Sesuvium maritimum. Shores of Oyster Pond; V R. The only other stations for it known in New York State are at Easthampton and Gardiner'ssIland.

Alsinaceae

Cerastium arvense. Downs; C.
Arenaria caroliniana. Hither Woods; V R.
Moehringia lateriflora. Near Hither Woods, at contact of woods and downs; R R.
Honkenya peploides. Beaches; C.
Tissa marina. Fort Pond; R R.

Caryophyllaceae

Silene caroliniana. Near Fort Pond; R R.

Nymphaeaceae

Brasenia Schreberi. Pond near Ditch Plain; V R.
Castalia odorata. Most stable ponds; R C. The much smaller-flowered *C. odorata pumila* is also found with the type, and a pink-flowered form is not unknown.

Ceratophyllaceae

Ceratophyllum demersum. Ponds, Montauk Point; V R.

Ranunculaceae

Aquilegia canadensis. Point Woods; Hither Woods; R.
Anemone quinquefolia. Point Woods; R C.
Anemone virginiana. North Neck woods; V R.
Syndesmon thalictroides. Island in Great Pond; V R.
Ranunculus delphinifolius. Pool in wooded kettlehole near Gin Beach; V R.
Thalictrum revolutun. Point Woods; R R.

Lauraceae

Sassafras Sassafras. Hither Woods; Wooded kettleholes; Point Woods. R R.
Benzoin aestivale. Island in Great Pond; Point Woods; R R.

Cruciferae

Lepidium densiflorum. Shores of Gardiner's Bay; R R.
Cakile edentula. Sea beaches; R C.

Droseraceae

Drosera intermedia. Bogs; R R.
Drosera rotundifolia. Bogs; C.

Hamamelidaceae

Hamamelis virginiana. Point Woods; Island in Great Pond; R R.

Rosaceae

Spiraea latifolia. Early wooded stage of open kettlehole; C.
Spiraea tomentosa. Southeast of Inn; R R.
Potentilla canadensis. Edges of woods; Downs; C. The form known as *P. pumila* is also found.
Potentilla monspeliensis. Downs; R R.
Argentina littoralis. Brackish marshes; C.
Fragaria virginiana. Point Woods; Wooded kettleholes; C.
Sanguisorba canadensis. Marshes; R C.
Geum canadense. Oyster Pond; R.
Rubus Chamaemorus. Between the Inn and Culloden Point; V R. See page 24.
Rubus flagellaris. Hither Woods; R R.
Rubus frondosus. Hither Woods; wooded kettleholes; R C.
Rubus hispidus. Wooded kettleholes; V C.
Rubus nigrobaccus. Kettleholes; Hither Woods; C.
Rubus procumbens. Scrambling all over the downs and through most thickets; V C.
Rosa carolina. Thickets; C.
Rosa palustris. Thickets; often on the downs; C.
Rosa virginiana. Thickets; V C.

Malaceae

Aronia arbutifolia. Everywhere in low places; V C.
Aronia atropurpurea. In low places; C.
Aronia melanocarpa. Low places; V C.
Amelanchier canadensis. Wooded kettleholes; Hither Woods; Point Woods; C.
Amelanchier intermedia. Point Woods; R C.
Amelanchier nantucketensis. Hither Woods; wooded kettleholes; R R.
Crataegus albicans. Oyster Pond; V R.
Crataegus Arnoldiana. Montauk Point; V R.
Crataegus intricata. Point Woods; V R.
Crataegus Crus-galli. Near Culloden Point; R R.
Crataegus pruinosa. Wooded kettleholes, and Point Woods; R R.

Amydgalaceae

Padus virginiana. In most wooded kettleholes; Hither Woods; Montauk Point; C.
Prunus maritima. Beaches and many places in interior; V C.

Caesalpiniaceae

Chamaecrista fasciculata. Downs; R R.

Fabaceae

Baptisia tinctoria. Downs; V C. See note on page 21.
Meibomia marylandica. Hither Woods; R R.
Meibomia obtusa. Gin Beach; Hither Woods; R R.
Lespedeza capitata. Downs; R C.
Lespedeza frutescens. Downs; C.
Lespedeza procumbens. Hither Woods; R R.
Lathyrus maritimus. Beaches; V C.
Strophostyles helvola. Thickets; R C.
Glycine Apios. Hither Woods; thickets; low open kettleholes; C.

Geraniaceae

Geranium maculatum. Point Woods; Island in Great Pond; R R.

Oxalidaceae

Xanthoxalis Brittoniae. Downs; R R.
Xanthoxalis cymosa. Downs; C.

Linaceae

Cathartolinum intercursum. Downs; R R.
Cathartolinum medium. Downs; C.
Cathartolinum striatum. Low kettleholes; C.

Polygalaceae

Polygala cruciata. Low open kettleholes; Montauk Point; R C.
Polygala polygama. Downs; V C. The white-flowered form rather common.
Polygala viridescens. Downs; C.

Euphorbiaceae

Acalypha virginica. Edge of Hither Woods; R R.

Callitrichaceae

Callitriche heterophylla. Montauk Point; V R.

Anacardiaceae

Rhus copallina. Wooded kettleholes; Hither Woods; V C.
Rhus glabra. Hither Woods and Point Woods; R R.
Rhus hirta. Hither Woods and Point Woods; V R.
Toxicodendron radicans. Nearly everywhere; V C.
Toxicodendron Vernix. Wooded kettleholes; V C.

Aquifoliaceae

Ilex opaca. Point Woods; Reed Pond; Hither Woods; R R.
Ilex verticillata. Wooded kettleholes; Point Woods; V C.

Aceraceae

Acer rubrum. In all wooded parts; V C. The form known as *A. caroliniānum* seems to be the only one at Montauk.

Balsaminaceae

Impatiens biflora. Wooded kettleholes; R R.

Vitaceae

Vitis aestivalis. Wooded kettleholes; C.
Vitis Labrusca. Wooded kettleholes; C.
Parthenocissus quinquefolia. Nearly everywhere; V C.

Tiliaceae

Tilia americana. Island in Fort Pond; V R.

Malvaceae

Hibiscus Moscheutos. Brackish marshes; V C. Pale and even white-flowered forms are also common.

Hypericaceae

Hypericum boreale. Low open kettleholes; V C.
Hypericum canadense. Thickets at Montauk Point; R R.
Hypericum majus. Oyster Pond; R R.
Hypericum mutilum. Downs; C.
Hypericum perforatum. Downs and in open kettleholes; V C. Introduced.
Hypericum punctatum. Downs and in open kettleholes. V C.
Sarothra gentianoides. Downs; V C.
Triadenum virginicum. Most low open places; V C.

Elatinaceae

Elatine americana. Kettleholes; V R.

Cistaceae

Crocanthemum canadense. Downs; Hither Woods; C.
Crocanthemum dumosum. Hither Woods; downs north of the Inn; R R.
Crocanthemum majus. Downs; C.
Hudsonia ericoides. Hither Woods; R R.
Hudsonia tomentosa. Beaches and sandy places; Downs; C.
Lechea maritima. Beaches and Downs; V C.
Lechea minor. Downs; Hither Woods; C.
Lechea villosa. Downs; C.

Violaceae

Viola cucullata. Point Woods, and some wooded kettleholes; R R.
Viola fimbriatula. Open downs; C.
Viola lanceolata. Low open kettleholes; V C.
Viola pallens. Point Woods; V R.

Cactaceae

Opuntia Opuntia. Near the Lighthouse; V R.

Lythraceae

Rotala ramosior. Kettleholes; V R.
Decodon verticillatus. In some low, nearly open kettleholes; C.

Melastomaceae

Rhexia virginica. Low open kettleholes; R C.

Onagraceae

Isnardia palustris. Low open kettleholes; C.
Ludwigia alternifolia. Low open kettleholes; C.
Epilobium coloratum. Oyster Pond; V R.
Epilobium lineare. Near North Neck Woods; Point Woods; V R.
Oenothera muricata. Downs; Low open kettleholes; beaches and sandy places; C.
Oenothera Oakesiana. Downs; Beaches and sandy places; C.
Kneiffia Allenii. Downs; C.
Kneiffia fruticosa. Kettleholes and open downs; V C. The forms to which the names *linearis* and *longipedicellata* have been applied, also occur at Montauk, but I have followed Dr. F. W. Pennell in considering them as mere forms of the type.
Kneiffiia pumila. Hither Plain; R.
Circaea lutetiana. Point Woods; Reed Pond; R R.

Haloragidaceae

Proserpinaca pectinata. Open kettleholes near Culloden Point; R C.
Proserpinaca palustris. Open kettleholes near Culloden Point; R C.
Myriophyllum humile. Pools; V R.

Araliaceae

Aralia nudicaulis. Hither Woods; Island in Great Pond; R C.

Ammiaceae

Hydrocotyle umbellata. Open kettlehole near Ditch Plain; Fort Pond; Great Pond; R C.

Sanicula canadensis. Oyster Pond; R R.
Sanicula gregaria. Reed Pond; R R.
Sanicula marylandica. North Neck Woods; R.
Cicuta maculata. Low, open kettleholes; C.
Deringa canadensis. In rich woods, Reed Pond; R R.
Sium cicutaefolium. Wet places; R C.
Ptilimnium capillaceum. Low open stage of kettleholes; V C.
Heracleum lanatum. Rich woods; Reed Pond; R R.

CORNACEAE

Cornus alternifolia. Island in Great Pond; V R.
Cornus Amomum. Oyster Pond; V R.
Cornus florida. Point Woods; R R.
Nyssa sylvatica. Most wooded kettleholes; V C.

CLETHRACEAE

Clethra alnifolia. In most wooded kettleholes; Montauk Point; V.C

PYROLACEAE

Pyrola elliptica. Island in Great Pond; Hither Woods; R.
Chimaphila maculata. Woods near Reed Pond; V R.

MONOTROPACEAE

Hypopitys insignata. Hither Woods; V R.

ERICACEAE

Azalea viscosa. All wooded kettleholes; V C.
Kalmia latifolia. Hither Woods; Point Woods; R C—at these two places, almost unknown elsewhere. At the Point Woods some of the specimens are the largest seen on Long Island.
Xolisma ligustrina. Wooded kettleholes; Point Woods; R R.
Epigaea repens. Hither Woods; Point Woods; R R.
Gaultheria procumbens. Most wooded places; R R.
Uva-ursi Uva-ursi. In Hither Woods, or along edges of them; R R. Not covering bare ground by the acre, as it does at Napeague or on Nantucket.

VACCINIACEAE

Gaylussacia baccata. Hither Woods and Point Woods, rare between; R C.
Vaccinium angustifolium. Hither Woods; Point Woods: R C.
Vaccinium atrococcum. Montauk Point; wooded kettleholes; R.
Vaccinium corymbosum. Nearly everywhere; V C.
Vaccinium vacillans. Hither Woods; R C.
Oxycoccus macrocarpus. Bogs, most common towards the Point; V C.

Primulaceae

Samolus floribundus. Island in Great Pond; V R.
Steironema lanceolatum. Thickets; low open kettleholes; R C.
Lysimachia quadrifolia. In woods; V C.
Lysimachia terrestris. Low open kettleholes; V C.
Trientalis borealis. Point Woods; Hither Woods; R C.

Gentianaceae

Bartonia virginica. Kettleholes; Downs; R C.

Apocynaceae

Apocynum cannabinum. Thickets; R R.
Apocynum pubescens. Thickets; R R.

Asclepiadaceae

Asclepias amplexicaulis. Hither Woods; R R.
Asclepias pulchra. Kettleholes; R C.
Asclepias syriaca. Thickets; C.
Asclepias tuberosa. Downs; R.

Convolvulaceae

Convolvulus repens. Low open kettleholes; R R.

Boraginaceae

Myosotis virginica. On the Downs; R C.

Verbenaceae

Verbena hastata. Thickets; R C.
Verbena urticifolia. Reed Pond; R R.

Lamiaceae

Teucrium littorale. Low open kettleholes; V C.
Trichostema dichotomum. Downs; Hither Woods; R C.
Scutellaria galericulata. Island in Fort Pond; V R.
Stachys hyssopifolia. Low open kettleholes; C. The form known as *S. atlantica*, and scarcely distinguishable from the type, is also found.
Stachys palustris. Montauk Point; R R.
Koellia incana. Downs; R R.
Koellia mutica. Downs; R R.
Lycopus americanus. Low open kettleholes; C.
Lycopus rubellus. Low places; R R.
Lycopus uniflorus. Low places; R R.
Lycopus virginicus. Low places; V C.

Mentha canadensis. Oyster Pond; R R.
Collinsonia canadensis. Reed Pond; V R.

Scrophulariaceae

Linaria canadensis. Downs; R C.
Scrophularia leporella. In woods, and also in sand along north edge of Great Pond; Island in Great Pond; R R.
Chelone glabra. Swamps in Point Woods; R R.
Mimulus ringens. Oyster Pond; R R.
Gratiola aurea. Low open kettleholes; V C.
Ilysanthes dubia. Low open kettleholes; R C.
Limosella aquatica. Oyster Pond; V R. The only known station on Long Island.
Agalinis acuta. Downs; V C.
Agalinis purpurea. Downs and low open kettleholes; R C.
Melampyrum lineare. Hither Woods; Point Woods; R R.
Pedicularis canadensis. Downs and along edges of woods; Montauk Point; R R.

Lentibulariaceae

Utricularia macrorhiza. Pools; V R.

Orobanchaceae

Leptamnium virginianum. Hither Woods; Reed Pond; R R.

Phrymaceae

Phryma Leptostachya. Island in Great Pond; V R.

Plantaginaceae

Plantago aristata. Downs; R R. Introduced.
Plantago major. Brackish marshes; R C. But only as to the form known as *P. halophila.*
Plantago maritima. Montauk Point; R R.

Rubiaceae

Cephalanthus occidentalis. Low wooded kettleholes; V C.
Galium circaezans. Woods; R R.
Galium Claytoni. Low open and sometimes in wooded kettleholes; V C.
Galium pilosum. Low open kettleholes; Downs; C.
Galium tinctorium. Thickets; R R.

Caprifoliaceae

Sambucus canadensis. Low wooded kettleholes; Montauk Point; R C.
Viburnum dentatum. Low wooded kettleholes; R R.

Viburnum venosum. In most wooded places; V C.

Triosteum perfoliatum. On open downs near Inn; also Island in Great Pond; R R.

Lobeliaceae

Lobelia inflata. Montauk Point; V R.

Ambrosiaceae

Xanthium echinatum. Beaches; R C.

Compositae

Eupatorium hyssopifolium. Downs; C.

Eupatorium perfoliatum. Low open kettleholes; V C.

Eupatorium Torreyanum. Downs near Culloden Point; V R. Collected by William C. Ferguson, and reported by him also (Torreya **22**: 49. 1922) from Garden City and "Hempstead Plains."

Eupatorium trifoliatum. Thickets and woods; R R.

Eupatorium urticaefolium. Edge of woods, Reed Pond; R R.

Eupatorium verbenaefolium. Open and wooded kettleholes; R C.

Mikania scandens. Oyster Pond; V R.

Lacinaria scariosa. Downs near Hither Woods; R.

Chrysopsis falcata. Downs; V C.

Chrysopsis mariana. Downs; Hither Woods; C.

Solidago altissima. Island in Great Pond; Woods at Reed Pond; R.

Solidago bicolor. Hither Woods; Downs; R C.

Solidago caesia. Gin Beach; R R.

Solidago juncea. Downs; Montauk Point; R C.

Solidago neglecta. Bogs and low open kettleholes; V R.

Solidago nemoralis. Downs; C.

Solidago odora. Gin Beach; Reed Pond; R R.

Solidago rugosa. Thickets and kettleholes; V C. The plant known as *S. asperula* appears to be common with the type.

Solidago sempervirens. Brackish marshes and sand dunes; C.

Solidago serotina. Wooded kettleholes; R R.

Solidago speciosa. Montauk Point; V R.

Solidago ulmifolia. Montauk Point; V R.

Euthamia graminifolia. Open kettleholes; V C.

Euthamia tenuifolia. Open and wooded kettleholes; downs; Hither Woods; C. The form often called *E. minor* is also known.

Sericocarpus asteroides. Downs; Montauk Point; V C.

Aster cordifolius. Wooded kettleholes; C.

Aster divaricatus. Reed Pond; V R.
Aster dumosus. Downs; V C.
Aster ericoides. Open downs; Hither Woods; Point Woods; C.
Aster lateriflorus. Hither Woods; Reed Pond; R R.
Aster multiflorus. Wooded kettleholes; downs; C.
Aster novae-angliae. Near Prospect Hill; Reed Pond; R R.
Aster novi-belgii. Wooded and open kettleholes; R C. Also the forms known as *A. novi-belgii elodes* and *A. novi-belgii atlanticus.*
Aster paniculatus. Thickets; R R. Also as to form *simplex.*
Aster patens. Downs; Hither Woods; open kettleholes; C. Also well represented as to the form *A. phlogifolius.*
Aster puniceus. R R.
Aster spectabilis. Wooded kettleholes; R R.
Aster subulatus. Salt marshes; R R.
Aster tenuifolius. Salt marshes; R R.
Aster undulatus. Hither Woods; V R.
Aster vimineus. Thickets; V R.
Erigeron pulchellus. Low kettleholes; occasionally on the downs; R R.
Leptilon canadense. Downs; R C.
Ionactis linariifolius. Downs; V C.
Baccharis halimifolia. Salt marshes; R R.
Pluchea camphorata. Brackish marshes; R R.
Antennaria neodioica. Hither Plain; R R.
Antennaria plantaginifolia. Downs; V C.
Anaphalis margaritacea. Open kettleholes; downs; V C.
Gnaphalium uliginosum. Shore of Oyster Pond; V R.
Helianthus strumosus. Reed Pond; V R.
Echinacea pallida. Sparingly introduced on the downs; V R.
Coreopsis rosea. Low open kettleholes; R R.
Bidens connata. Low open kettleholes; R R.
Bidens discoidea. Low open kettleholes; R R.
Artemisia caudata. Beaches; R C.
Artemisia Stelleriana. Beaches; R C.
Erechtites hieracifolia. Kettleholes; downs; R C.
Cirsium discolor. Downs; R R.
Cirsium horridulum. Downs; R C. See page 21.

CICHORIACEAE

Cynthia virginica. Downs; V R.
Krigia virginica. Hither Woods; V R.

Lactuca sagittifolia. Gin Beach. V R.
Hieracium Gronovii. Downs; R C.
Hieracium marianum. Downs; C.
Hieracium scabrum. Downs; C.
Hieracium venosum. Downs and in dry wooded kettleholes; V C.
Nabalus serpentarius. Point Woods; R R.
Nabalus trifoliolatus. Hither Woods; Culloden Point; Montauk Point; R R.

The list enumerates 495 species contained in 261 genera which may be grouped as follows:

	Genera	Species
Ferns and fern allies	11	18
Gymnosperms	2	2
Angiosperms		
Monocotyledons	59	147
Dicotyledons	189	328
Totals	261	495

While these 495 species undoubtedly make up the great bulk of the flora of Montauk, 227 of them are either "common," "rather common" or "very common," and it is these elements which constitute the major features of the *vegetation* of the point. As shown elsewhere, and as a check of the foregoing list will verify, a trifle over 65 species are "very common" and it is these that give characteristic vegetative covering to great stretches of the Downs and wooded kettleholes.

Some years ago the Raunkiaer "growth-form" scheme of sorting species into different categories, according as they are suited to carry over their unfavorable season, was applied to the writer's "Flora of the Vicinity of New York," and to the 400 commonest species of the general flora of Long Island.*

At that time the opinion was expressed that the scheme did not satisfactorily indicate the response of either the total flora or of the four hundred commonest species of Long Island to the climate. It was hoped that in such a specialized region as Montauk the sorting would give us better results. The following table shows how far short Raunkiaer's scheme comes of reflecting the climatic conditions there. The percentages are as follows:

* Am. Jour. Bot. **2**: 23–31. 1915. Mem. Brooklyn Bot. Gard. **1**: 486–491. 1918. The details of Raunkiaer's growth-forms are given there, and will not be repeated here.

	MG	MS	MC	N	CH	H	G	HH	T
Normal Spectrum		6.	17.	20.	9.	27.	3.	1.	13.
Flora Vicinity of New York	.52	4.3	7.18	3.51	5.29	33.29	20.23	11.74	13.
Total Long Island flora	.89	4.37	6.34	2.77	5.89	33.15	20.10	10.90	13.94
400 common species of Long Island	1.50	3.	8.50	4.25	7.25	30.	21.	6.75	14.25
Total flora of Montauk		**1.6**	**11.4**	**3.1**	**6.9**	**32.6**	**19.2**	**11.2**	**13.5**
Commonest species of Montauk (including C., R.C., V.C.)		**2.2**	**10.1**	**5.7**	**6.1**	**30.3**	**19.3**	**11.4**	**14.5**

The significant thing about these percentages appears to be this: They agree pretty closely, except for the perfectly natural absence of tall trees, with those of the total flora of the Island, and this in spite of the fact that the climatic conditions of Montauk are very different from the rest of the Island. Assuming, as we must, that the age of the flora of Montauk is approximately that of the rest of the Island, we are faced with the proposition of a vegetative covering in marked contrast to Long Island generally, the components of which are simply the usual aggregation of Long Island *species*, but grouped in such very different percentages from the rest of the Island that the floral aspect of Montauk is unique. There are no endemic species there, and all but a handful of the rarest Montauk plants are found elsewhere on Long Island. This general agreement of the *flora* of Montauk with the rest of the Island, which the foregoing list of species will easily verify, is perhaps what is to be expected. But the failure of the growth-form percentages to reflect the very unusual sorting of these species-components of the Montauk vegetation, is perhaps the best local illustration of the failure of that scheme to reflect the response of plants to climate. As shown elsewhere in this account, that response has been rather definite, and has resulted in such a sorting of species that herbs vastly outnumber woody plants as *individuals*. And yet neither for the total Montauk flora nor for the chief species-components of its major vegetative features is there any but trifling indication in the Raunkiaer percentages of this response of the flora to the climate.

The absence of endemics there is perhaps of interest. Assuming again, as I think we must, that the flora of Montauk, with the rest of Long Island, began with what may, for the want of a better term, be called a definite capital or stock in trade of species, that capital has not, in the thousands of years that it has been subjected to the peculiar (for Long Island) conditions of Montauk, changed its components in sufficient amount to have produced endemic species. This comparative fixity of plant materials, it might even be called the immutability of Montauk species gives decided

color to the many arguments that species originate very slowly, even although conditions, apparently favorable for species segregation, such as the undoubtedly severe environment at Montauk, are at hand.* It may possibly be true also, that botanists who erect species concepts upon finer lines than the current manuals, would see in the dwarf, stunted or wind-wrenched specimens of the Montauk flora, a host of nascent species, in which the present writer sees merely ecological variations, or response to the local conditions there. A good illustration of this is the species that occur both in the wooded kettleholes and out on the open downs. Luxuriance in the one place and thwarted endeavor in the other to produce normal growth are constantly met with in the flora of Montauk.

The age of this flora,—it is, of course, all post-glacial,—cannot be fixed definitely. In an attempt to fix the relative age of different floras by the percentages of monocotyledons and dicotyledons,† Harper has shown that the former vary between 28% and 32.3% of the total flora in the glaciated region which he has studied. The percentage of monocotyledons at Montauk, also a glaciated region, but subject to invasion from the adjacent coastal plain, is 30.9%. Present ideas of the relative antiquity of monocotyledons may, however, put a different interpretation upon the proportion of them in any flora.

Another rather interesting feature of the plants of Montauk in relation to the environment is the so-called generic coefficient of the flora.‡ In brief this proposition is that in regions of diverse ecological conditions there will be a relatively higher proportion of genera produced than in a region of generally similar character. The plan has been tried for many regions and everywhere the generic coefficient (the proportion of genera to species in any given flora) is high where conditions are pretty uniform, lower where the conditions are diverse.

For the regions nearest Montauk, considering both introduced and native species the generic coefficients are as follows:

* This is in harmony with the statement of Professor M. L. Fernald at the recent meetings of the Botanical Society of America. In his paper "The Antiquity of species as indicated by Insular and Peninsular Floras of Eastern Canada" he postulates comparative fixity of species over long periods of years—25,000 years.

† Harper, R. M. A statistical method for comparing the age of different floras. Torreya **5**: 207–211. 1905.

‡ For an account of the details of this, first proposed by Professor Paul Jaccard, see Bull. Soc. Vaudoise Sci. Nat. **37**: 547–579. 1901. *loc. cit.* **44**: 223–270. 1908. New Phytologist **11**: 37–50. 1912. Rev. Gen. Bot. **26**: 1–47. 1914. Also a paper by Professor J. W. Harshberger on "The diversity of ecologic conditions and its influence on the richness of floras." Proc. Philadelphia Acad. Nat. Sci. **67**: 419–425. 1915.

	Generic coefficient
Flora of Long Island*	35.0
Flora of the Vicinity of New York	31.3
Connecticut Flora	31.9
New Jersey Pine-barrens	45.0
which should be contrasted with	
Montauk	52.6

Perhaps better than any other statistical method of studying a flora this Jaccardian generic coefficient reflects the uniformity of Montauk conditions and the effect upon the flora of that consistent topography and climate. As compared to the total flora of the vicinity of New York with 31.3%, and the Flora of Long Island with 35.0%, the 52.6% generic coefficient of Montauk is noteworthy as an expression by the flora of the relative ecological diversity of the larger areas, as compared to the relative uniformity of the smaller one.

* Based on the manuscript "Flora of Long Island," and doubtless not quite complete, but there is little evidence that additions will change the percentage more than a point or two.

From Montauk Point.

I stand on some mighty eagle's beak,
Eastward the sea absorbing, viewing,
(nothing but sea and sky),
The tossing waves, the foam, the ships in
the distance,
The wild unrest, the snowy, curling caps—
that inbound urge and urge of waves,
Seeking the shores forever.

Walt Whitman